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LOW RATE INITIAL PRODUCTION IN ARMY AVIATION SYSTEMS DEVELOPMENT

by

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Low Rate Initial Production in Army Aviation Systems Development

by

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The purpose of this thesis is to analyze DoD's use of Low Rate Initial Production (LRIP) on selected Army Aviation programs within the acquisition life cycle of weapon systems development. A comparative analysis is conducted on the selected programs concentrating on significant issues which affect the use of LRIP. The thesis focuses on the pre-production phases of the acquisition process, the organizations that influence LRIP policies and future trends in procurement policy. The research includes an examination of the AH-64 Longbow Apache, the OH-58D Kiowa Warrior, the MH-47 and the EH-60 Special Operations Aircraft and the RAH-66 Comanche. This thesis concludes that premature entry into LRIP is a systemic deficiency in acquisition oversight which leads to a proliferation in the required number of LRIP systems. A recommendation to overcome this deficiency and obtain a more accurate number is to identify the three LRIP quantity determination elements separately. This would provide the Milestone II Decision Authority more accurate data with which to render a decision.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to analyze DoD's use of Low Rate Initial Production (LRIP) on selected Army Aviation systems as it applies to the present day acquisition life cycle of weapon system development. Many program reviews have indicated that LRIP is not being used effectively to manage program risks inherent in the transition from development to production. The focus of this thesis is to analyze and compare selected programs and provide significant issues which affect the use of LRIP. Additionally, it will recommend appropriate actions that could reduce the risk of transitioning from development to production.

B. BACKGROUND

The dissolution of the Soviet Union, together with the current U.S. inventories of highly capable weapons, represent opportunities for change in the acquisition process. One change could entail reducing the need to utilize a high risk acquisition strategy such as concurrency and fostering more limited rate production. Concurrency is simply undertaking production before development is complete. While this may reduce the time span from concept to deployment, it involves a commitment of substantial costs. These costs may be

wasteful in the event of program design modification, cancellation, or redirection. The use of LRIP is one approach to mitigate this risk. [Ref. 14]

LRIP is a term describing a low rate of output at the beginning of the manufacturing program to reduce the Government's exposure to large retrofit programs and resulting costs, while still providing adequate numbers of hard tooled production items for final development and operational test prior to a full production release [Ref. 12]. The test and evaluation conducted on these systems verify that the production process provides material that meets the required technical and operational performance requirements of the system. When the decision authority believes that the system would not perform to expectation, a decision to not proceed beyond LRIP would be made and further testing would result.

The defense acquisition decisions made over the next few years will be especially critical because they are intertwined with the rewriting of national security policy and the military strategy. Decisions on the next generation weapons will define solutions to defense policy needs, dictate budgets for the remainder of the decade, and either take advantage of or miss the opportunity to improve the acquisition process. [Ref. 1]

As we progress through a period of declining threat and correspondingly fewer defense dollars, the number of programs entering LRIP will probably increase. The primary reasons for

this increase include the perceived benefits of risk reduction, the capability to "prove-out" emerging technologies, and the ability to identify good candidates for cost reducing manufacturing technologies.

To improve the acquisition process and take advantage of the benefits resulting from the end of the Cold War, acquisition managers should review acquisition policies and guidance to ensure that they completely analyze the mission needs, costs, and alternatives. This will ensure that cost-effective solutions are matched to valid needs before substantial resources are committed to their programs. Increasing the utilization of LRIP to reduce risk in new programs can be a vital part of this new approach.

C. THESIS OBJECTIVES

The primary objective of this thesis is to analyze how LRIP has influenced procurement programs in terms of cost, schedule and performance. Therefore, it will focus on analyzing the pre-production phases of the acquisition process, the organizations that influence LRIP policies, and the future trends in procurement policy.

D. RESEARCH QUESTIONS

1. Primary Research Question

What impact does Low-Rate Initial Production have on procurement programs?

2. Subsidiary Questions

a. What is LRIP and how is it used in the acquisition process?

b. What are the reasons a program enters LRIP?

c. What rationale is used to determine the proper number of LRIP articles to meet operational test requirements?

d. Can prototype systems substitute for LRIP aircraft?

E. SCOPE

The focus of this thesis is to examine the process that Army Aviation System Program Managers go through to determine how LRIP is used within the program. The research includes an examination of the following Army Aviation Programs: The AH-64 Longbow Apache, the OH-58D Kiowa Warrior, MH-47 & EH-60 Special Operations Aircraft, and finally the RAH-66 Comanche. This study will be limited to the historical aspects of LRIP use on Army Aviation Force Modernization development.

F. METHODOLOGY

Background and policy information, obtained by reviewing applicable publications, included recent studies, periodicals, and GAO reports. Additionally, Defense Logistics Studies Information Exchange (DLSIE) conducted a search for related information. Interviews with personnel internal and external to the Aviation and Troop Command (ATCOM) were conducted.

These included current and former aviation program managers, Defense Systems Management College (DSMC) subject matter experts in testing and production, and members of the Army's Operational Test and Evaluation Command (OPTEC). From this investigation, a comparative analysis was conducted to derive issues which may be of interest to future development systems.

G. ORGANIZATION

Chapter II is a historical perspective on past acquisition reforms, the current regulatory guidance, standards, and background literature. The milestones and phases of the acquisition life cycle where LRIP is planned and executed follows. Additionally, a discussion of some of the more popular acquisition strategies is presented here.

Chapter III presents the requirements for proper planning and preparation when incorporating LRIP in an acquisition strategy. Additionally, the systems engineering principles deemed necessary for proper transition from development to production are identified.

Chapter IV is an assessment of the selected Army Aviation programs. The focus is narrowed to the planning and use of LRIP as an acquisition strategy, the degree of development and operational testing, and the outcomes resulting from these.

Chapter V presents an analysis of the data obtained from the selected programs. This analysis will specifically address the implications arising from the use and/or misuse of LRIP.

Chapter VI states the conclusions, recommendations and summarizes the answers to the research questions. It closes with recommendations of areas for future research.

II. LRIP IN THE ACQUISITION LIFE CYCLE

A. INTRODUCTION

This chapter will discuss acquisition reforms and the reasons that require them. Additionally, it will discuss LRIP as it is currently used in the acquisition life-cycle. It will highlight key aspects of the milestone decisions and phases where accomplishment of LRIP planning takes place. Following this, an identification and discussion of the minimum regulations and guidance policies that program managers should become familiar with are presented. Finally, a discussion of two popular acquisition strategies, fly-before-buy and concurrency, will be addressed.

B. ACQUISITION REFORM

Persistent management problems that have plagued our acquisition programs, such as cost growth, schedule slippage, and poor production, are nothing new. They may not be caused solely by program management errors, lack of expertise, or unforeseen events [Ref. 1]. Many problems arise because of the acquisition process itself. As a weapon system progresses from concept formulation to production and deployment, it is constantly threatened, stretched, debated, delayed, and even restructured by the many people who are part of the program development process [Ref. 1]. These "key players" have their

own political agenda which might or might not be in the best interest of the program. Political agenda or parochial preferences range from members of Congress responding to constituents, to Service executives whose tenures are often short and consequently make short term decisions, to each Service who wants to secure its reputation and obtain a share of the diminishing defense budget. This is partly the reason why problems with weapon system development persist despite the numerous reforms of the past thirty years.

The success of reforms as defined in the larger sense of laws, DoD regulations, outside panels, and recommendations from independent organizations, has been limited not because these reforms embodied bad ideas or focused on the wrong issues. [Ref. 1] In fact, reforms have been created to correct a majority of the most well recognized acquisition problems such as, developing more accurate cost estimates, enhancing stability, improving the quality of the acquisition workforce, etc. However, many acquisition reforms have not been effective because the parochial preferences that motivate the "key players" have not changed [Ref. 1].

Organizations responsible for developing requirements for new weapons generally represent individual branches within the Services that analyze their own mission area deficiencies and recommend solutions. When the Army Aviation Center identifies deficiencies based on its analysis of the threat, it tends to propose solutions in terms of helicopters. When the Air Force

recommends solutions, it endorses fixed wing aircraft. Such parochial reviews of missions and requirements, coupled with each Service's unwillingness to compromise on design or performance goals, contribute to the Service unique systems proposed to achieve a common mission. Programs justified on the basis of their unique characteristics make it difficult to assess which alternative best serves DoD and can lead to conflict between the optimism of the individual Service programs and the skepticism that accompanies the organizations charged with oversight of the programs. [Ref. 1]

New reforms were developed to reduce cost and schedule overruns, to increase program stability, to emphasize realistic testing, or simply to improve the efficiency of the acquisition process to ensure a smooth transition into production. Figure 1 identifies some of the major acquisition reforms that date back to the McNamara initiatives of the early 1960's and continue up to the present time with the DoD 5000 series publications incorporating the milestone and phase development process.

The Defense Acquisition Improvement Act, better known as the Carlucci Initiatives, consisted of 32 initiatives designed to address long-standing problems with major weapon systems acquisition. Some of the problems were significant cost overruns, schedule slippage, and performance shortfalls.

Conversely, the intent of the Packard Commission was to provide a new acquisition culture so that decisions on

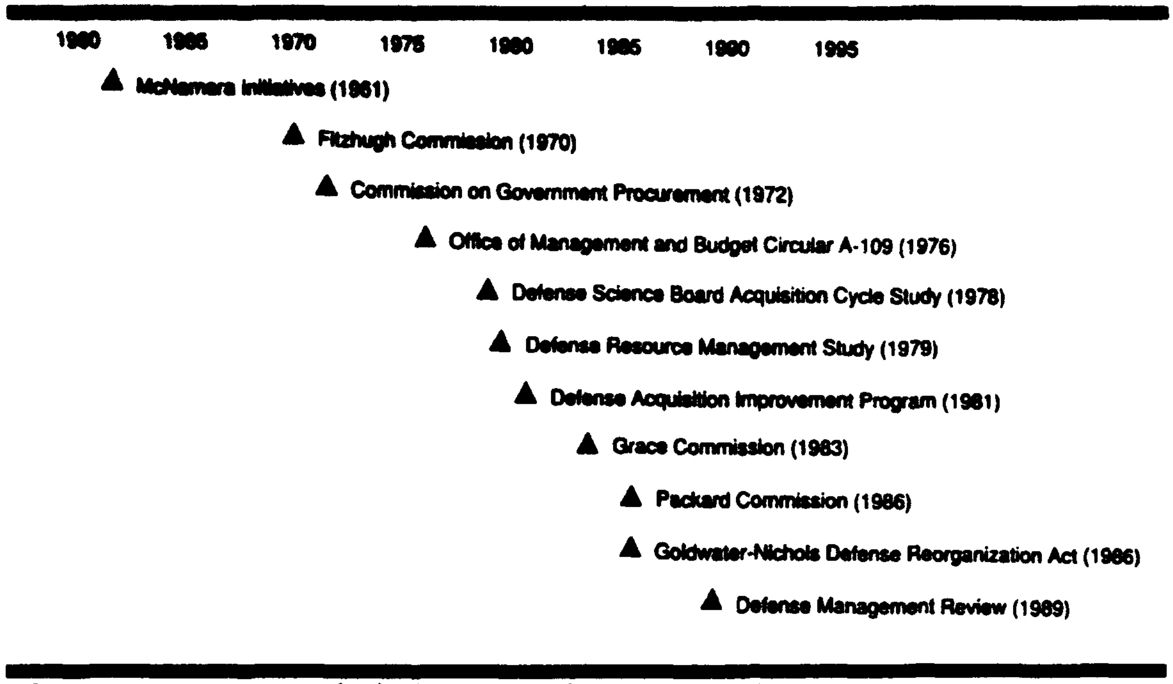

Figure 1 Key Acquisition Studies and Reforms (Source: GAO/NSIAD-93-15); **WEAPONS ACQUISITION**

producing a major weapon system would be based on realistic program information and sound production practices. The Commission proposed a streamlined organization for weapon systems acquisition management and recommended a new Under Secretary who would have full-time responsibility for managing the defense acquisition system. The Commission also recommended that each Service establish a comparable senior position whose job would mirror that of the Defense Acquisition Executive (DAE).

The Goldwater-Nichols DoD Reorganization Act complemented the Packard Commission's recommendations and required the Services to reorganize their headquarters acquisition management structures. All these past reforms were met with

initial enthusiasm, but, once the enthusiasm had dissipated, the reforms' influence soon waned.

The Defense Management Review and the Section 800 panel are the latest in the procession of reforms designed to address and abate many of the acquisition problems. These initiatives included increased acquisition training, more independent cost analyses, and revisions to acquisition regulations that emphasized a technical, event-based approach to acquisition management. [Ref. 1] These approaches included a major effort to ensure fulfillment of milestone exit criteria before proceeding to the next phase and integrating defense acquisition practices with the commercial workplace.

The concept of producing small amounts to verify production readiness was considered in some of these reform efforts. However, the concept of LRIP is relatively new. Some of the reforms "packaged" the concept of LRIP as a resource savings measure and provided guidance on reducing the risks of transitioning from development to production. To assist in implementing the LRIP concept and ensuring compliance, the reforms also provided for some DoD oversight. Although external oversight is a necessary step, internal guidance designed to assist in the preparation for LRIP is imperative.

C. REGULATIONS AND GUIDANCE

With the vast literature on acquisition policy and regulation, it is virtually impossible for program managers to be acquainted with all of them. This section highlights the acquisition references pertaining to the use and implementation of LRIP.

Recently, the Air Force has developed the Air Force Acquisition Model (AFAM) which provides an automated encyclopedia of the entire acquisition process from concept formulation to retirement. All required acquisition regulations are now on-line for instant access.

1. DoD Directive 5000.1

Department of Defense Directive 5000.1, dated February 23, 1991 is the top level document that "establishes a disciplined approach for acquiring systems and materiel that satisfy the operational user's needs" [Ref. 2]. It provides a one stop reference source that identifies all applicable documents and regulations pertaining to weapon systems development, and it defines the acquisition cycle in terms of milestones and phases.

2. DoD Instruction 5000.2

Department of Defense Instruction 5000.2, dated February 23, 1991 requires that program acquisition strategies be event-driven, with entry into LRIP and full-rate production based on accomplishing specific program results

[Ref. 3]. These program results are more commonly referred to as exit criteria.

3. DoD 4245.7-M, "Transition from Development to Production"

"Transition from Development to Production," dated September 1985, provides guidance on minimizing risks associated with transitioning from EMD to production through accomplishment of prerequisites in design, test, and production readiness [Ref. 4]. The events are transformed into templates that describe techniques for improving the acquisition process.

4. DoN NAVSO P-6071, "Best Practices-How to Avoid Surprises in the World's Most Complicated Technical Process"

This is a follow on to the efforts of the Defense Science Board Task Force on the DoD Manual 4245.7-M "Transition from Development to Production." It enhances both Government and industry processes by identifying specific practices and their potentially adverse consequences in terms of cost, schedule, performance, and readiness. [Ref. 5]

5. Military Standard 1521-B, "Technical Reviews and Audits for Systems, Equipment and Computer Software"

Technical Reviews and Audits for Systems, Equipment, and Computer Software identifies technical reviews and audits

required of acquisition programs at various stags. As systems proceed through development, the reviews provide feedback concerning the suitability of system hardware and software design and the risks associated with production decisions. [Ref. 6]

6. United States Code (Title 10)

The following sections of Title 10 of the United States Code are pertinent to the acquisition procurement process. [Ref. 7]

Section 138 - Director of Operational Test and Evaluation (DOT&E)

Section 138 authorizes the DOT&E as the SECDEF advisor on OT&E. The term Operational Test is described as the field test, under realistic combat conditions, for the purposes of determining the effectiveness and suitability of the weapon for use in combat by typical military users. Evaluation is the appraisal of the results of the test. Section 138 also states that Operational Testing of a major defense acquisition program may not be conducted until the Director has approved in writing the adequacy of the plans for OT&E. Additionally, a final decision to proceed beyond low rate initial production may not be made until the Director submits his recommendation to the SECDEF.

Section 2430 - Definition of MDAP

The term "Major Defense Acquisition Program" means a DoD acquisition program that is not a sensitive classified program and that is designated by the Secretary of Defense as a major defense acquisition program; or that is estimated by the Secretary of Defense to require an eventual total expenditure for research, development, test, and evaluation of more than $300,000,000 (based on FY90 constant dollars) or an eventual total expenditure for procurement of more than $1,800,000,000 (based on FY90 constant dollars). The Secretary of Defense may adjust the amounts (and the base FY) based on DoD escalation rates.

Section 2399 - Beyond LRIP

This section addresses issues that must be considered before approval to proceed beyond LRIP is granted and includes the following guidelines.

a) *Major Defense Acquisition Program (MDAP)*

A major defense acquisition program may not proceed beyond LRIP until Initial Operational Test and Evaluation is completed.

b) *Operational Test and Evaluation (OT&E)*

OT&E of a MDAP may not be conducted until DOT&E approves the adequacy of test plans. At the conclusion of testing the Director prepares a report addressing:

1) the adequacy of the Test & Evaluation, and

2) whether the OT&E results confirm or negate system effectiveness and suitability.

c) *Determination of the Quantity of Test Articles*

The quantity of articles of a new system that is to be procured for operational testing shall be determined by the DOT&E for all MDAPs. The determination of articles for non-MDAPs rests with the Operational Test and Evaluation agency for the military department concerned.

d) *Impartiality of Contractor Testing Personnel*

In the case of a MDAP, no person employed by the contractor for the system being tested may be involved in the conduct of the test. This limitation does not apply to the extent the SECDEF plans for persons employed by that contractor to be involved in the operation, maintenance and support of the system being tested when the system is deployed in combat.

e) *Impartial Contracted Advisory and Assistance Services*

The Director may not contract for advisory and assistance services with regard to T&E of that system if that person participated in or is participating in the development, production, or testing of such system for a military department.

f) *Operational Assessments*

Operational assessments may be used in conjunction with OT&E. However, operational assessments based exclusively on computer modeling, simulation, analysis of system requirements, engineering proposals, design specifications, or any other information in program documents, may not be used for the purposes of determining the effectiveness and suitability of a weapon system.

Section 2400 - Low Rate Initial Production of New Systems

This section addresses the decision process for determining the quantity of LRIP articles and provides guidelines for determining that quantity.

a) *Determination of Quantities to be Procured for LRIP*

The determination of the quantity of articles for a system that should be procured for low-rate initial production shall be established by the Milestone II decision authority. The term "Milestone II decision authority" means the decision to approve the Engineering and Manufacturing Development phase of a major system by the official of the DoD designated to have the authority to make that decision.

b) *Requirements for Low Rate Initial Production of New Weapon Systems*

The guidelines for establishing Low Rate initial production with respect to a new system are:

- Production of the system in the minimum quantity necessary to provide production-configured or representative articles for test;
- To establish an initial production base for the system; and,
- To permit an orderly increase in the production rate for the system sufficient to lead to full-rate production upon the successful completion of operation testing.

Section 2633 - Survivability Testing

This section requires that a MDAP system may not proceed Beyond Low-Rate Initial Production (BLRIP) without realistic survivability testing.

D. PHASES OF ACQUISITION DEVELOPMENT

The key features of the acquisition process are described in DoD Instruction 5000.2. [Ref. 3] The phases, punctuated by key milestone points are depicted in Figure 2. The following discussion will highlight each milestone decision point and acquisition phase where LRIP is pertinent.

1. Milestone 0, Concept Studies Approval

Milestone 0 marks the initial formal interface between requirements generation and the acquisition management system. The decision to proceed from this point does not establish a

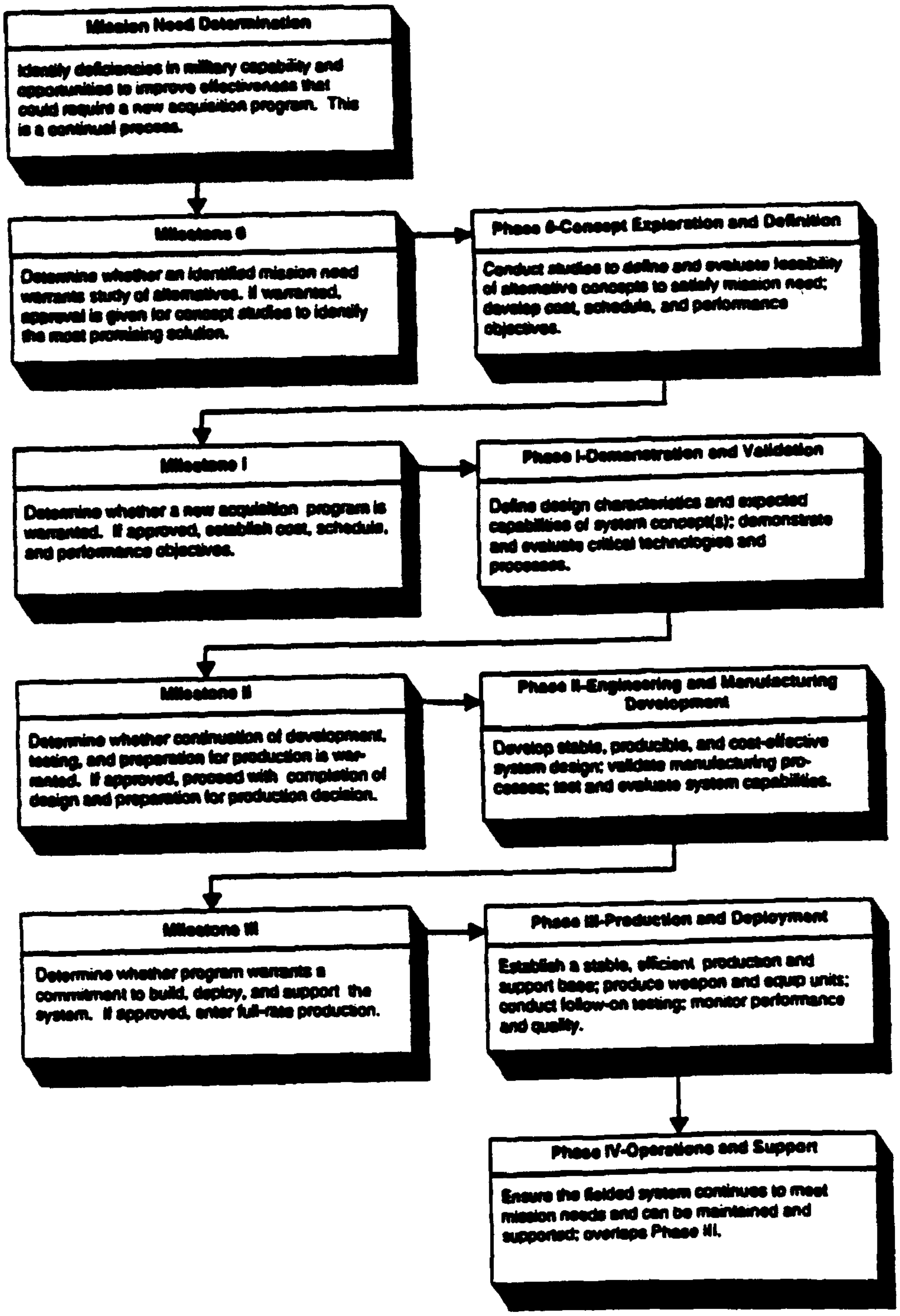

Figure 2 DoD's System Acquisition Process (Source: GAO/NSIAD-93-15); WEAPONS ACQUISITION

new acquisition program. Instead, it reflects approval to proceed with studies of alternative concepts that could satisfy the identified mission need.

The Acquisition Decision Memorandum (ADM) is the tool used by the Under Secretary of Defense for Acquisition and Technology which reflects the decisions made and the direction provided by the Deputy Secretary and allows for program continuation into the next development phase.

The Acquisition Decision Memorandum for this decision point should:

- Define the minimum set of alternative concepts to be examined,
- Identify the lead organization or organizations for the study effort,
- Establish any exit criteria information or analyses that must be presented at Milestone I, and
- Identify the dollar amount and source of funding for the study efforts to be conducted.

2. Phase 0, Concept Exploration and Definition

The focus during this phase is on defining and evaluating the feasibility of alternative concepts and providing the basis for assessing the relative merits of the concepts at the Milestone I, Concept Demonstration Approval, decision point. The acquisition strategy should provide for the validation of the technologies and processes required to achieve critical characteristics and meet operational

constraints. It takes the results of exploratory development, non-Government applied research and development efforts, and known or perceived Army needs, to identify and define new or improved systems.

3. Milestone I, Concept Demonstration Approval

Milestone decision authorities, for the appropriate ACAT levels, must assess the affordability of a proposed new acquisition program at Milestone I. Affordability of the program can be determined utilizing affordability assessments. These assessments are defined in terms of the life-cycle resource requirements. They must compare program resource requirements against affordability constraints and other resource demands over the planned life-cycle. A favorable decision at this milestone establishes a new acquisition program, a Concept Baseline and authorizes entry into Phase I, Demonstration and Validation. A program management office should be established with the identification of a Program Manager within 6 months. Additionally, acquisition strategies must provide for the milestone decision authority to determine the quantities to be procured for low-rate initial production at the Milestone II decision point according to 10 U.S.C. 2400.

The Acquisition Decision Memorandum for this decision point should:

- Approve the initiation of a new program and entry into Phase I, Demonstration and Validation,
- Approve the proposed or modified acquisition strategy and concept baseline,
- Establish program specific exit criteria that must be accomplished during Phase I, and
- Identify affordability constraints derived from the planning, programming, and budgeting system.
- Identify Low rate initial production quantities, if appropriate.

4. Phase I, Demonstration and Validation

The Demonstration and Validation phase is where the principal program characteristics are validated. It relies on hardware and software development and evaluation rather than paper studies, since these provide a better definition of program characteristics, higher confidence regarding risks, and greater confidence in the ultimate outcome. Ideally, this phase concludes with the construction and evaluation of an Advanced Development Model. A refined acquisition strategy should identify the minimum required accomplishments for this phase to include identifying high risk areas, the risk management approach for these areas and low-rate initial production quantities. The quantity determination should be a joint venture between the program manager, the prime contractor and the DOT&E. They should consider the

fabrication complexity of the system, the length of the production period, the availability of funds, and the testing requirements.

5. Milestone II, Development Approval

Milestone decision authorities must determine whether continuation of development, testing, and preparation for production are warranted. They must rigorously assess the affordability of the program and establish a Development Baseline at this decision milestone. If approval is obtained, the program can proceed with completion of design and preparation for production decision.

The Acquisition Decision Memorandum for this decision point should:

- Approve entry into Phase II, Engineering and Manufacturing Development,
- Approve the proposed or modified acquisition strategy and Development Baseline,
- Establish program specific exit criteria that must be accomplished during Phase II, and
- Confirm the low-rate initial production quantities.

6. Phase II, Engineering and Manufacturing Development

The EMD phase is where detailed design, fabrication, and testing of the system is accomplished. This includes all items necessary for the system's support. The intended output is a hardware/software system whose performance and reliability has been proven experimentally, along with the

documentation needed to support competitive production. During this phase, one or more Engineering Development Models may be produced and tested. As these models mature they may be used as LRIP articles. The low rate initial production experience should verify the adequacy of the manufacturing process, confirm the stability and producibility of the design, and provide a realistic estimate of production costs. This phase concludes with a Technical and Operational Evaluation.

7. Milestone III, Production Approval

A favorable decision at this point represents a commitment to build, deploy, and support the system. Milestone decision authorities must determine if the results of Phase II, EMD, warrant continuation and an establishment of a production baseline containing refined program cost, schedule and performance objectives. It is important to note that the decision authority shall not approve proceeding beyond low-rate initial production until initial operational test and evaluation of the program is complete.

The Acquisition Decision Memorandum for this decision point should:

- Approve entry into Phase III, Production and Deployment,
- Approve the proposed or modified acquisition strategy and Production Baseline, and
- Establish program specific exit criteria that must be accomplished during Phase III.

8. Phase III, Production and Deployment

The Production and Deployment phase is when the system, including training equipment, spares, etc., is produced in sufficient numbers to support its planned deployment. System performance, quality, and operational readiness rate will be monitored to assess the ability of the system to perform as intended and to incorporate into its production lots minor engineering change proposals to meet required capabilities. Additionally, identification of the need for major upgrades or modifications that require a Milestone IV, Major Modification Approval, review will be accomplished.

E. ACQUISITION STRATEGIES

1. Fly-Before-Buy

Fly-Before-Buy generally refers to building and testing prototypes of a weapon system to ensure that the weapon system is technically feasible before selection for further developments are made. Fly-before-buy has been supported by public law, DoD regulations, the Packard Commission, and the Defense Management Review.

Confusion regarding the terms prototype and LRIP have historically led to inconsistencies in acquisition policy and strategies. Prototyping has been used in many different ways including use as a low rate production article and consequently, many different prototyping strategies have been

applied to weapon system development programs. With the changing acquisition environment in terms of declining budgets and fewer new program starts, it becomes even more imperative to distinguish between the role of prototyping and the role of LRIP.

In his study of the nature and role of prototyping, Jeffrey Drezner identifies three key elements that are required when defining a prototyping strategy. The three elements are timing, level of system integration, and goals. [Ref. 8] Timing relates to the technical maturity and phase of the acquisition cycle in which prototyping occurs. This includes the planning as well as the actual fabrication. The level of system integration is described as identifying the extent to which the prototype represents a production representative system, which includes all necessary subsystems for deployment. The third element, goals, addresses the various types of risk and uncertainty managers may face. This is accomplished by generating information that improves the management of that risk or uncertainty.

The "goals" element is further divided into two levels to identify the kinds of information a manager can expect to receive by utilizing a prototype strategy. The first level concerns the overall purpose of prototyping in the program; the second, the specific objectives of particular prototypes. The following are the overall purposes of the prototyping phase and are considered the most aggregate of the two levels.

Level One: Overall Purpose - Overall purposes are closely related to the expected benefits of prototyping and the decision stage of the program. Usually only one main purpose is relevant to a single program but it is not uncommon to have more. The overall purposes are Technology Viability, Technology Demonstration, System Performance Validation, and Marketing.

- *Technology Viability:* Generating basic technical information to reduce technological risk in a general sense. These are the 'building block' prototypes, intended to add to the general knowledge base. They generally occur very early in a program, often before Dem/Val at Milestone I.

- *Technology Demonstration:* Exploring the possible performance envelope of a system. Prototypes in this category are often used to explore the usefulness of a new design or concept in performing a specific mission, or to demonstrate a particular application of technology. These prototypes may occur early in the program in CE or Dem/Val at a time when the design is not frozen. Production of an operational system is often anticipated. This is in contradiction to the current DoD policy on Advanced Technology Demonstration which does not anticipate any production.

- *System Design/Performance Validation*: This involves design and performance specifications or requirements. Also included here are demonstrations of the ability to meet a specified threat, contract specifications, and producibility concerns. Missions are specified, and there is an expectation of production. This category might also be called 'engineering,' since these prototypes are often fabricated as part of EMD efforts.

- *Marketing:* This has to do directly with selling a product or supporting a proposal. These prototypes are often close to production configuration. These can be part of any decision phase prior to production. Missions do not need to be specified, though the prototypes are oriented toward a specific functional requirement.

Using the same set of categories as the main purposes, the secondary purposes are intended to capture those aggregate level goals that may be less important than the primary purpose, but still represent an important focus of the prototype program [Ref. 8]. Drezner identifies a second level that he calls specific objectives that define the many possible uses of prototypes and concedes that one prototype may serve several objectives.

Level Two: Specific Objectives - Specific objectives relate to the rationale underlying fabrication of the prototype and to the specific information generated [Ref. 8]. The following 11 objectives, as defined by Drezner, differ somewhat from those addressed by the 5000.1 acquisition regulations.

- *Experimental:* This demonstrates a new idea, a new technology, or an existing technology in a new application. This usually occurs very early in the program and may not have particular mission or production expectations.

- *Exploratory:* This evaluates the possible performance envelope or tests the feasibility of a performance requirement. It may not have a mission specified or expectations of production, but does have explicit performance goals. This usually occurs in the CE or Dem/Val phases.

- *Feasibility:* This demonstrates performance objectives concerning a specific mission. This usually occurs in the Dem/Val phase, though production may not be expected.

- *Competitive:* This is used to improve source selection decisions in Dem/Val or EMD phases. Production is anticipated when utilizing this objective.

- *Developmental:* This determines operational suitability and utility for military use. It may occur in the CE or Dem/Val phases. This is the missionized version of an experimental prototype. This is in contradiction with DoD policy which identifies an engineering development prototype as one which is derived from Type 'C' (product) specifications and is not intended to determine the operational suitability of a system.

- *Political:* This achieves some political or corporate strategy objective, demonstrates attainment of a political objective, or responds to a politically established requirement. This can occur throughout the decision process, though it occurs most often in Dem/Val or EMD.

- *Integration:* This tests subsystem matching and full system operation. It may be part of the CE, Dem/Val, or EMD phases. Specific mission or functional requirements exist.

- *Pre-production:* This objective tests production configuration after design freeze, usually during EMD. Producibility concerns are relevant. Full rate production is expected.

- *Missionized:* This evaluates performance with respect to a specified threat using a fully integrated system. This may occur in CE, Dem/Val, or EMD phases.

- *Operational:* This tests the operational suitability of fully integrated systems, including reliability, availability, and maintainability characteristics. It is also used for doctrine development and integrated logistics support planning.

- *Upgrade:* This objective tests or demonstrates subsystem improvement to existing systems in operational use. It occurs either during the production phase of existing platforms or as a separate retrofit program.

Table 1 shows that certain objectives are intuitively associated with particular main purposes. It becomes apparent that as the objectives progress from experimental to upgrade, the prototype increasingly resembles a final production configuration. These relationships result from the kinds of

TABLE 1 COMMON PURPOSE-OBJECTIVE ASSOCIATIONS

PURPOSE	OBJECTIVE
Technology Viability	Experimental Exploratory
Technical Demonstration	Feasibility Development
System Design/ Performance Validation	Integration Pre-production Missionized Operational Upgrade
Marketing	Political Competitive

(Source: Drezner; The Nature and Role of Prototyping, Rand, 1992)

risk and uncertainty addressed in each purpose and objective category, as well as the level of system integration and phase of the program.

2. Concurrency

According to an April 1990 USD(A) report on guidelines for determining the amount of risk appropriate for major acquisition programs, concurrency is defined as the overlap in time between the development of a weapon system and its production [Ref. 17]. DoD's policy on major weapon system acquisition stresses the importance of minimizing the time to develop, produce, and deploy major systems for use by operational forces. It also provides a framework for applying concurrency and requires documentation that would substantiate

the need for concurrency. [Ref. 2] Additionally, DoD's policy permits the Services to build concurrency into their weapon program structure.

In a nonconcurrent program, development is usually completed before production begins. In a concurrent program, production is started while development is still underway. Figure 3 depicts an example of both concurrent and nonconcurrent program structures.

The report specifies that the degree of concurrency will be based on the savings in acquisition time balanced against cost, risk, and urgency of the mission need in each acquisition program. The report also responded to Section 801 of the National Defense Authorization Act for FY 90 & 91, which required establishing guidelines for:

- Determining the degree of concurrency that is appropriate for the development of major Defense acquisition systems; and
- Assessing the degree of risk associated with degrees of concurrency.

The concurrency guidelines specific to the LRIP decision included:

- Ensuring that the acquisition strategy will provide confidence that a stable design exists before the program moves into LRIP (LRIP validates the production process and the design must be stable at this point);
- Establishing clear exit criteria for initiation of long-lead funding for LRIP and for entry into LRIP;

- Ensuring that all development testing is properly time-phased so technical problems are highlighted before they become critical; and

- Ensuring that engineering development articles, which usually will be used to perform the testing upon which initial production decisions will be made, are representative of the production configuration.

Concurrency can be an effective technique for expediting acquisitions if it is well planned and controlled; however, the practice increases the risk that systems will be produced with major flaws. This requires that adequate safeguards be built into any program to minimize the risks of utilizing concurrency. At the very least, these safeguards should provide for performance of at least one phase of OT&E and the completion of planned OT&E before production. [Ref. 9] Additionally, the degree of concurrency should remain a planned part of the program and not dictated by uncontrolled or unplanned events. So if delays in scheduled tests arise, a corresponding delay in any production decision should occur.

Risks associated with concurrency should be identified and assessed throughout the program development to avoid unplanned delays in scheduled OT&E before LRIP. [Ref. 9] OT&E results are important because they provide early identification of problems and can help prevent costly retrofits and performance shortcomings. But if production decisions are delayed until all deficiencies are corrected, the program may become stigmatized, inviting critics and

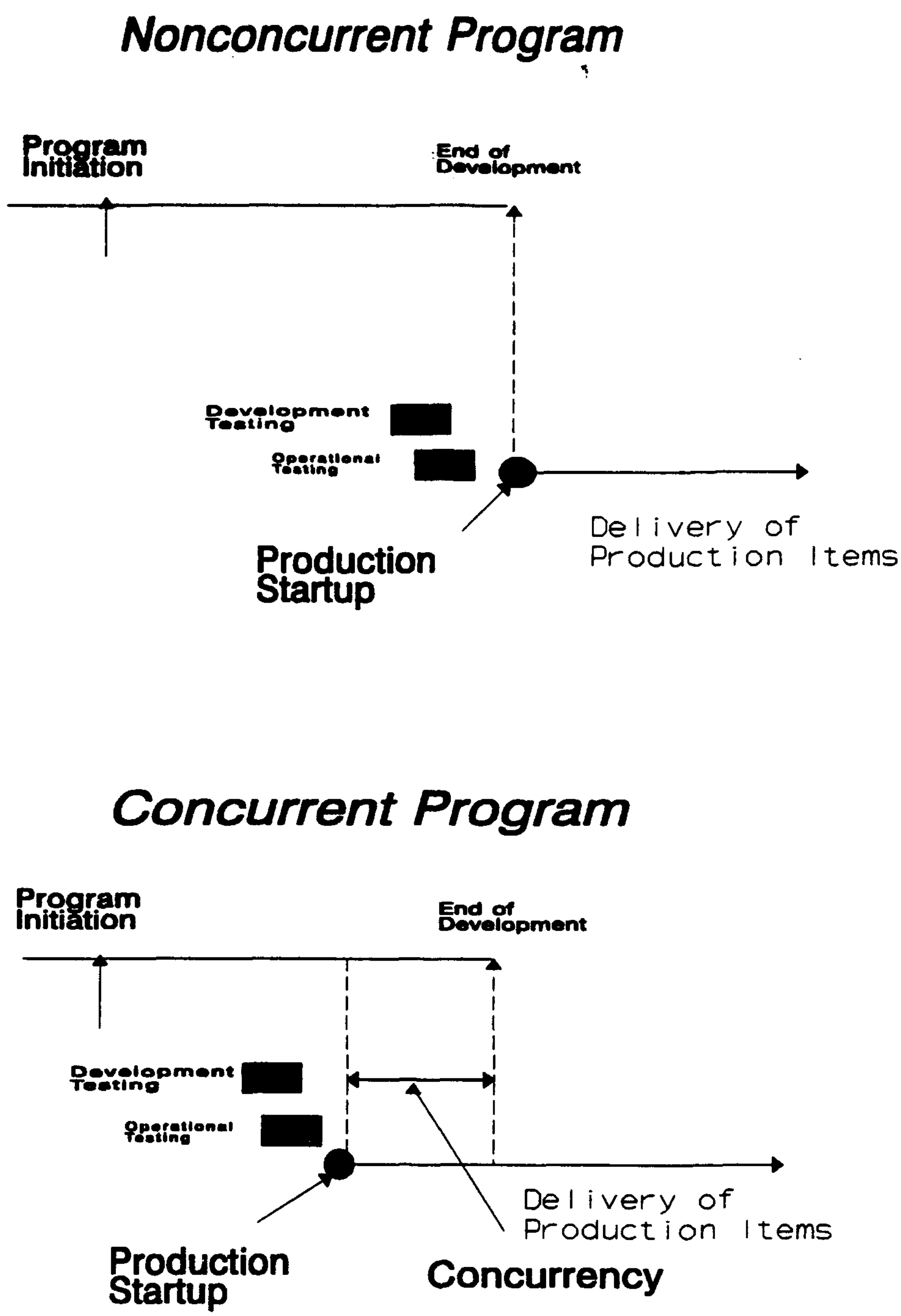

Figure 3 Examples of Program Structure (Source: 17 APR 1990 USD(A) Report on Guidelines for Determining Appropriate Development Risk

budget cutters to converge on it [Ref. 1]. Thus, while concurrency poses risks that run counter to sound management, it appeals to the stronger motives of gaining commitment to a program before negative information can become available. The recurring theme is that completion of some OT&E prior to LRIP is an especially important safeguard against the increased risks of concurrent programs. [Ref. 10]

3. LRIP

Low Rate Initial Production is the production of a system in limited quantity to provide articles for operational test and evaluation, to establish an initial production base, and to permit an orderly increase in the production rate sufficient to lead to full-rate production upon completion of operational testing [Ref. 11]. It is also commonly known as conservative concurrency. LRIP has two major purposes. The first purpose is designed to demonstrate that the production or manufacturing process is capable of producing the required items in the required quantities at the minimum cost. The second purpose is to produce "production representative" items for the completion of Development Testing (DT) and Operational Testing (OT). The key here is the term "production representative" which may or may not be synonymous with the term prototype, depending on your position and political point of view.

In addressing the first purpose, it is critical to address producibility in the initial planning and design phase. The Department of the Navy stated in its *Best Practices* manual:

> Besides the more obvious performance and reliability requirements, there is the additional demand of producibility: it must be economically feasible to manufacture a quality product at a specified rate and to deliver end items capable of achieving the performance and reliability inherent in the design. This design requirement is not always well understood and historically has taken a back seat to the more popular objective of high performance. The results of this neglect have ranged from factory rework rates in excess of 50 percent to suspension of government acceptance of end items pending major redesign for producibility. A strong producibility emphasis early in design will minimize the time and cost required for successful transition to production. [Ref. 5]

This type of planning is used to help minimize the risk of committing the necessary resources for the production phase by allowing for test and tryout of the manufacturing equipment and process prior to full production release.

Of course there are problems associated with choosing this or any other production approach. If the design deficiencies cannot be worked out, no acquisition strategy or production approach will suffice. The introduction of DoD 4245.7M states:

> Many programs simply cannot succeed in production, despite the fact that they've passed the required milestone reviews. These programs can't succeed for technical reasons, notwithstanding what is perceived as prior management success related to DoD acquisition policy. A poorly designed product cannot be tested efficiently, produced, or deployed. In the test program there will be

far more failures than should be expected. Manufacturing problems will overwhelm production schedules and costs. The best evidence of this is the 'hidden factory syndrome' with its needlessly high redesign and rework costs.[Ref. 4]

The difficulty in implementing LRIP is the need to invest in manufacturing tooling and test equipment earlier in the acquisition cycle [Ref. 12]. This can prove to be a very costly experience to both industry and Government should a new flexible manufacturing strategy, such as Advanced Technology Demonstration, be congressionally mandated for a particular system [Ref. 13].

The second purpose, that of producing "production representative" articles for Operational and Development Testing, is quite different from the first purpose. Production representative articles are more important for Operational Testing than Development Testing but are preferred for both. A 1990 GAO report on weapons testing identified Development Testing as:

> Development test and evaluation is done throughout the acquisition process to ensure the attainment of technical performance specifications, program objectives, and weapon system supportability. Development testing is normally done by the agency responsible for developing the system. It uses such techniques as modeling, simulation, prototypes or LRIP models to determine the extent that a system meets technical specifications.[Ref. 14]

The GAO report went on to describe Operational Testing as:

> A field test, under realistic conditions, of major weapons systems, for the purpose of determining operational

> effectiveness and suitability of the weapon system used in combat by typical military users. Initial OT&E is that portion of actual OT&E done throughout the acquisition process before the decision to proceed to production. It is accomplished using a prototype, pre-production article, or a low-rate initial production article as the test item. The 'final exam,' or the latter phase of initial OT&E usually entails dedicated operational testing of production representative test articles using typical operational personnel in as realistic a combat environment as possible. [Ref. 14]

The terms operational effectiveness and suitability are two categories of operational testing. Operational effectiveness is the ability of a system to accomplish its mission when placed in use in the planned operational environment. Operational suitability is the degree to which a system can be placed satisfactorily in the field.

4. Summary

This chapter has provided the background for the complex and challenging environment in which DoD systems are procured. One finding of a recent IG report indicated that premature entry into LRIP was caused by inadequacies in the milestone review process, regulations, and policy guidance for LRIP [Ref. 14]. In addition to the IG finding, research indicates that program planning has historically been accomplished when the urgency to meet the threat justified highly concurrent development and production efforts. The preceding discussion and review of the acquisition process was necessary in order to gain an understanding of the significance of the findings that impacted on LRIP.

III. THE PLANNING PROCESS

A. INTRODUCTION

The DoD policy on Defense Acquisition Management, which implements 10 USC 2400, is that Low Rate Initial Production quantities are approved at Milestone II. [Ref. 16] This is a change from the previous DoD 5000 series publications which called for approval at Milestone IIIA. However, DoD Instruction 5000.2 does not contain direction on determining the LRIP quantities to be produced or the milestone exit criteria required to be demonstrated before entry into LRIP. This chapter will discuss the historical problems associated with readiness for low-rate initial production followed by a discussion addressing the prominent problems in determining LRIP quantities and commitments.

B. READINESS FOR LOW-RATE INITIAL PRODUCTION

According to a recent Inspector General report, many acquisition programs entered LRIP without completing prerequisites in design maturity, development and operational testing, and proper configuration management. Premature entry into LRIP was caused by inadequacies in the milestone review process, not following regulations, and lack of policy guidance. Program planning was accomplished when the urgency to meet threats justified highly concurrent development and

production efforts. [Ref. 15] The report indicates that there are three critical decision points that precede entry into LRIP. The decision points are:

- The MS II, Development Approval, which approves the program acquisition strategy of LRIP and LRIP quantities;
- LRIP long-lead funding approval; and
- LRIP approval.

At the Milestone II decision point, DoD Instruction 5000.2 requires that the Director, Operational Test and Evaluation, determine the quantities of LRIP articles required for operational testing. [Ref. 3] Change 1, dated 26 February 1993, states that authority to proceed with LRIP may require a separate program review and milestone decision authority approval at a point specified in the Milestone II decision. [Ref. 16] However, as mentioned before, DoD Instruction 5000.2 does not contain directions on determining the LRIP quantities to be produced or the exit criteria required to be demonstrated prior to entry into LRIP. Therefore, program managers are left to their own accord when making these decisions.

The second decision point is the obligation of long-lead funding to support entry into LRIP. The long-lead funding decision point represents the commitment of funds to initiate production-related activities. A 1990 USD(A) report to Congress on concurrency guidelines proposed that clear exit

criteria be established for initiation of long-lead funding for LRIP and that the decision to commit funds be supported by operational test assessments [Ref. 17]. As was the case with the first decision point, DoD Instruction 5000.2 does not establish a policy for the commitment of long-lead funding for LRIP. Therefore, wide variations of LRIP strategies have evolved.

The third decision point associated with LRIP is the approval of entry into LRIP. As stated, the 1993 change to DoD Instruction 5000.2 suggests, but does not require, a program review and milestone decision authority approval of proceeding into LRIP. The new guidance also suggests that exit criteria be established and, when successfully passed, allow the program office to expand activities during an acquisition phase.

Finally, the new guidance states that additional activities or program reviews are triggered by failure to meet exit criteria established for proceeding into LRIP [Ref. 16]. This causes development schedules to slip to the right and jeopardizes the Initial Operational Capability (IOC) date.

C. PLANNING FOR LRIP

Present guidance provides some flexibility when planning for LRIP. Although flexibility is required to meet the specific requirements of many programs, the basic systems engineering management concepts such as design maturity,

producibility, testing, and production readiness are applicable to virtually all programs [Ref. 14]. It is therefore important to review each of the systems engineering management concepts required prior to an LRIP decision.

1. Design Maturity

Design maturity is defined in DoD 4245.7M. It states

> In an operational environment, a mature design meets operational requirements without Government or contractor intervention--no further field modifications or additional equipment and spares are required to overcome design shortfalls. In the factory, design maturity might be indicated by the tapering off of engineering change proposal traffic, once the test phase is underway. It can assume that contract requirements are being met.[Ref. 5]

High risk of failure in material acquisition programs occurs at the outset of the design process. While some level of risk associated with a new technical concept may be unavoidable, historically the risk has been magnified by the misunderstanding of the industrial design disciplines necessary to turn the concept into a mature product [Ref. 14].

Detailed design planning can help reduce the risks of proceeding into production with an immature design. In his book, *Systems Engineering and Analysis,* Blanchard addresses the requirements of detailed design. The basic design objectives for the system and its elements must be compatible with the operational requirements and the maintenance concept [Ref. 18].

The goal is to incorporate only the necessary characteristics to meet the requirement, not too many as to over-design and not too few as to under-design. It is important that programs not enter LRIP with many, if any, unresolved design problems. Programs entering LRIP without a mature, stable design, frequently experience production related problems and delays that introduce the need to make additional LRIP awards to preclude the costs associated with a break in production [Ref. 14].

2. Producibility

Blanchard defines producibility as "the characteristic of system design that allows for the effective and efficient production of one or a multiple quantity of items of a given configuration" [Ref. 17]. The manufacturing plan is the vehicle in which the contractor achieves his producibility goals. The manufacturing plan identifies the approach for duplicating a product configuration in a cost-effective manner. It is usually based on the results of detailed planning and analysis activities that have been conducted to define the optimum approach for product manufacture.

According to the Department of the Navy's *Best Practices* manual on "How to Avoid Surprises in the World's Most Complicated Technical Process," a manufacturing plan is normally submitted as a contract data requirement at the end of EMD, or early in LRIP [Ref. 5]. This type of approach

encourages late planning for product manufacture and precludes tradeoffs between manufacturing process alternatives and product design configurations. Additionally, the late planning causes many "surprise" product redesigns for producibility. Conducting manufacturing planning concurrently with the product design process will preclude most product redesign efforts for producibility considerations that would otherwise be revealed after LRIP. The *Best Practices* manual goes on to say that the manufacturing planning activities that should be accomplished before LRIP and addressed in the manufacturing plan include:

- Estimating manufacturing resource requirements
- Schedule definition
- Personnel requirements
- Make or buy decisions
- Facilities

Resource Requirements

The manufacturing process and procedures identify all requirements for tooling, capital equipment, and plant facilities. Therefore, an accurate definition of system requirements is necessary. Since the product design configuration has a direct influence on the manufacturing processes and procedures, determination of manufacturing resource requirements should be accomplished early in EMD.

Schedule Definition

The schedule presented in the manufacturing plan should provide assurance that the necessary resources will be available when needed. The details of the entire project schedule should be the top level planning baseline.

Personnel Requirements

The number of contractor personnel necessary to manufacture the product, the specific skill types, and the ability of the contractor to meet these requirements should be defined. Personnel plans should be consistent with the planned personnel requirements to ensure that adequate skill types and quantities are available and maintained.

Make or Buy

A make or buy plan establishes the distribution of effort between the prime contractor and the subcontractors. The percentage of weapon system components that are subcontracted can be as high as 80 percent. The make or buy approach can have tremendous impact in cost and schedule risk and must therefore be addressed in sufficient detail. Specific attention should be given to the make or buy decisions since there may be differences between overall contractor goals in structuring these decisions and the goal which the Government might consider appropriate for the project.

Facilities

The facilities include all plant and capital equipment necessary to accomplish product manufacture. Because this translates into large dollar amounts, a facilities plan should be addressed as part of the manufacturing plan.

3. Testing

An April 1990 USD(A) report to Congress concluded that the determination of whether a program is ready to enter LRIP must be based upon the totality of component, subsystem, and system testing that is done, and the results of this testing [Ref. 17]. Development testing, as mentioned earlier, requires that both the contractor and the Government conduct DT&E. To increase the efficiency of DT&E, the Government should participate in some of the contractor's testing. This will help eliminate redundant testing and provide more user oriented test results which should result in a more mature system for OT&E. Development testing is designed to insure that the design meets the technical specifications required for the system.

Operational Assessments are a quasi form of testing that should be considered in planning for use of LRIP. Operational Assessments are evaluations of operational effectiveness and suitability made by an independent operational test activity, with user support as required, on

other than production systems [Ref. 14]. Operational Assessments differ from operational test and evaluation because production systems are not required. The key differences with assessments are that they use technology demonstrators, prototypes, or engineering development models that should be, but are not required to be, "production representative" [Ref. 14].

Current DoD policy requires early and progressive assessments of operational capability, including realistic operational testing before full-scale production starts [Ref. 14]. The April 1990 USD(A) report to Congress stated that decisions to commit funds for LRIP can be supported by operational assessments [Ref. 17]. Performing early operational assessments when production representative test articles are not available is a step forward in filling a void in the availability of actual OT&E results.

LRIP is traditionally considered as a means by which test articles are acquired for OT&E. However, the Congress and DoD's Inspector General have expressed concern that the Services' use of LRIP has sometimes resulted in de facto full-rate production before any OT&E is conducted [Ref. 10]. In their view, program managers, fearing a threat of program disruption, have a strong incentive to get the production line started before data from the final phases of testing are available.

Operational assessments can be used here to identify significant trends noted in development efforts, programmatic voids, areas of risk, and the ability of the program to support adequate operational testing. This should help mitigate the Congress and IG's fears.

The *Best Practices* manual summarizes how testing and testing schedules should be planned. Most test schedules are planned to support the major milestone reviews that occur during the development of a weapon system. The tests are planned to provide positive test results for presentation at the milestone reviews, in order to obtain approval for the project to proceed to the next milestone [Ref. 5]. This leads to a test philosophy in which passing tests is the main objective of the test program, rather than considering the engineering need for the test or the technical information provided by the test results. If test schedules are not allowed sufficient time for redesign and retest, changes and retesting may be delayed until production equipment is available. If the changes prove incorrect and additional redesign is required, production units may have to be retrofitted and many ECPs may be required during the early phases of production. This will then limit the effectiveness and rationale behind using LRIP as part of the acquisition strategy. The overall success of a carefully integrated test program will result in a minimum of resources applied to

testing, a viable LRIP program, and the elimination of a costly ECP or retrofit program during production. [Ref. 5]

4. Production Readiness

DoD's policy is to begin planning for production early in the acquisition process to ensure that the weapon system design not only meets performance objectives but also can be produced in an economical and timely manner.

The Production Readiness Review (PRR) is the process used for ensuring the manufacturing operation and product documentation is ready for production. DoD Instruction 5000.2 defines a system as ready for production when the producibility of the production design and the managerial and physical preparations necessary for initiating and sustaining a viable production effort have progressed so that a production commitment can be made without incurring unacceptable risk [Ref. 3].

The PRR is a technical review of the completeness and producibility of the product design and the planning and preparation for production. Additionally, it typically addresses product design, industrial resources, production engineering and planning, materials and purchased parts, and quality assurance [Ref. 14].

The production readiness review must be satisfactorily accomplished before favorable LRIP or full production decisions are made. Properly planned, staffed, and executed,

PRRs are valid tools for assessing the depth of production engineering. The *Best Practices* manual identifies some key indicators at the reviews that will ensure that the manufacturing process is qualified, or at least on track. These include:

a. A low number of waivers and deviations on the parts and materials that are built per process specifications. The low number of ECPs ensures a mature design and mature manufacturing process, such that product integrity is measurable.

b. The existence of a 'hands on' personnel training program with a mechanism in place for personnel recertification.

c. Successful functional, physical, and configuration audits. Such audits add confidence and credibility to the maturity of both the design and the manufacturing process.

d. Adequate time and dollars to perform production trial runs to verify that skills have been acquired through training, that process instructions are usable and accurate, that capacity predictions are validated, and most important, that the process is in "statistical control" and is stable.

e. The existence of a periodic production test program. This test program will ensure that the production units are being built to the product baseline and inherent performance and quality is being maintained.

f. A single shift, eight-hour day, five day work week operation is planned for all production schedules, particularly during LRIP. [Ref. 5]

5. Summary

The Government can and frequently does, incur significant program risk from systems entering LRIP when their designs are not stable and readiness to enter the production process has not been verified. The significance of this

chapter was to emphasize that there is no substitute for proper production planning. Additionally, it provided specific actions intended to mitigate the risks of transitioning from development to production.

DoD regulations allow for some flexibility when developing an acquisition strategy. However, flexibility is less appropriate in ensuring that systems have a stable design, be producible, and be able to demonstrate the capability to pass realistic operational testing before a full rate production decision is made. There are many publications to assist program management organizations in the proper planning for production readiness. The LRIP planning process is just the first step to ensuring that the program management office's considerations for production include the complexity of the system, the total number to be procured, industrial base factors and the acquisition strategy most advantageous to the Government.

IV. AVIATION SYSTEMS

A. INTRODUCTION

This chapter will analyze four Army Aviation programs. These programs include the AH-64 Longbow Apache, the OH-58D Kiowa Warrior, the MH-47 and EH-60 Special Operations Aircraft and the RAH-66 Comanche. The focus of the analysis is narrowed to the current program status, the planning and use of LRIP as an acquisition strategy and the degree of development and operational testing supporting LRIP. Much of the data came directly from the individual program management staff members. Additional data were obtained from GAO reports and subject matter experts within the acquisition community. Particular attention was devoted to the determination of individuals involved in the LRIP decision process and the quantities of LRIP articles obtained by each program. The results from the analysis of these cases will provide lessons learned for future program development efforts.

B. AH-64 LONGBOW APACHE

1. Program Status

The Longbow Apache is a modification of the AH-64 Apache helicopter. The modification program calls for adding a mast-mounted, millimeter wave fire control radar, with a

passive radio-frequency interferometer, and a Hellfire missile. The millimeter-wave radar detects, classifies, and prioritizes both stationary and moving targets. The interferometer detects hostile radar emissions and provides the Longbow Apache information on the direction and identity of the opposing air defense weapon. The RF Hellfire missiles are known as the "Longbow" system. This "Longbow" system could be adapted to other types of helicopters in the future. [Ref. 19] In addition to the fire control radar and missile enhancements, the airframe will also be modified to include a fully integrated cockpit designed to reduce the pilot workload, expanded forward avionics bays to accommodate Longbow equipment and upgraded generators, and new wiring for the fire control radar.

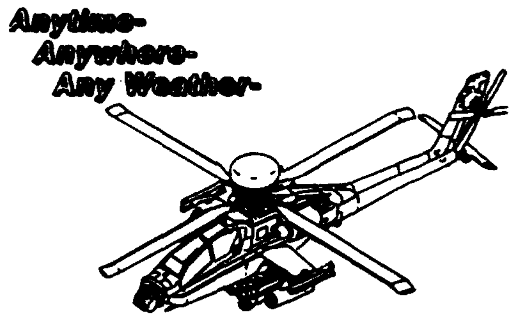

Figure 4 Longbow Apache

An EMD contract for the Longbow Apache was awarded to McDonnell Douglas Helicopter Company in August 1989. As the prime contractor for the AH-64 Apache, McDonnell Douglas Helicopter Company is developing the airframe modifications to accommodate the Longbow enhancements and is responsible for the total integration of the airframe, fire control radar and the missile system. [Ref. 19] The Army plans to begin low rate production in April 1995, with deliveries scheduled

through the year 2000. Figure 5 depicts the acquisition schedule for the Longbow Apache.

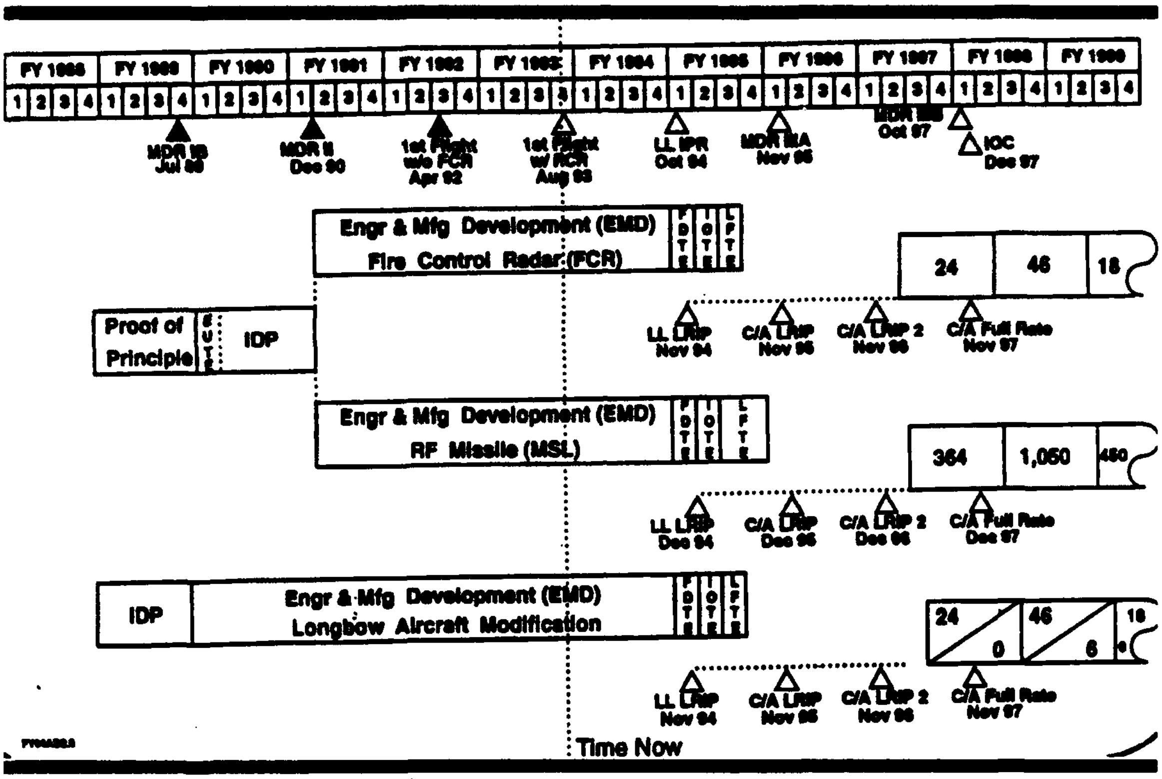

Figure 5 Longbow Apache Program Schedule (Source: Longbow Apache Program Office)

2. LRIP Planning

Since the Longbow Apache is a modification of the AH-64 Apache it is necessary to discuss the acquisition of the AH-64. According to a 1990 GAO report, the Apache entered production with an immature design and undemonstrated logistical supportability. [Ref. 20] Furthermore, there was no low rate initial production phase and no follow-on testing performed. This was in spite of the Army Materiel Systems Analysis Activity's (AMSAA) recommendation to enter limited production followed by another decision point to

reassess the supportability shortfalls and the impending design changes. In today's political and military climate in terms of acquisition oversight and budget constraints, it would be difficult for program managers to make similar decisions.

In discussing this issue with the program management staff, they consider the GAO report as an inaccurate representation of the facts. The program management office reported that the Apache did indeed proceed through an LRIP phase although they acknowledged that the term "LRIP" was not in vogue at the time [Ref. 21]. They admit that LRIP was not planned from the outset as an acquisition strategy in FY 82 primarily because it was not required. However, the program office did recognize from the outset that the initial production quantity would be small and that affordability, operational tests and initial production rates for smooth transition into full rate production were both logical and necessary.

According to the Apache Program office, the initial production quantity was based solely on affordability. Affordability by itself is not one of the three considerations mentioned in DoD 5000.1 when deciding on initial production quantities, but this seems to be the primary determinate in most cases. There were 15 aircraft planned as the initial production quantity but the number was reduced to 11 based upon a "Should Cost" determination of available funds and

subsequent negotiations with the prime contractor. In the case of the Apache, these first 11 aircraft were considered by the program office to be sufficient for completion of operational testing and for the establishment of an initial production base.

The contractor's role in determining LRIP quantities for the Apache was limited to responding to the Army's mission requirements and to propose the cost of satisfying those requirements. Affordability considerations forced compromises between the initial requirement of 15 and the resultant number of 11. Since the contractor is primarily responsible for two of the three LRIP quantity determination factors, it would seem astute to allow them more involvement in the decision process.

In contrast to the AH-64 Apache, the Longbow Apache modification program offers the opportunity to avoid many of the problems that occurred in the fielding of the Apache. [Ref. 22] Chief among the acquisition strategy features is its lack of concurrency. The production of the Longbow Apache is not planned to begin until the new millimeter-wave radar technology has been demonstrated to work.

The Longbow Apache acquisition strategy identifies the incorporation of an LRIP phase. According to information obtained from the program office, 24 aircraft are planned for LRIP with a contract award scheduled for November 1995

[Ref. 23]. The number was established in June 1992 and derived from budget/POM drills and the reductions in the Army's Total Obligation Authority (TOA). The PM and contractor would prefer a number ranging between 36 and 48 in order to meet the contractor's established minimum sustaining rate. Even though the contractor had established a minimum sustaining rate, they were not involved in the final LRIP quantity decision. It was based strictly on budget constraints. Table 2 indicates the initial and most current program milestone dates for the Longbow Apache.

TABLE 2 LONGBOW APACHE MILESTONE DATES

Longbow Apache	Initial	Current
Program Initiation	March 1983	Black Program
Dem/Val Milestone I	August 1985	August 1985
EMD Milestone II	December 1990	December 1990
LRIP Milestone IIIa	November 1994	November 1995 November 1996
Full Production Milestone III	November 1995	November 1997

(Source: Longbow Apache Program Office)

The Defense Acquisition Board (DAB), with its issuance of the Acquisition Decision Memorandum, has directed the PM to ensure that required system performance and reliability are demonstrated before moving into production. The Longbow program is currently scheduled to hold a long lead initial

program review in November 1994 with a DAB review in October 1995 to proceed into LRIP. Additionally, there is a second LRIP contract award for 46 aircraft scheduled for November 1996. Following the second LRIP decision there is a full production milestone scheduled for November 1997.

The key to this acquisition strategy is that the Army will delay making an LRIP decision until initial operational testing and evaluation has been completed. This will allow the Longbow Apache program to proceed only as fast as technology will permit.

3. Testing

The Longbow Apache test program is designed to provide the data necessary for proper decision making. [Ref. 22] The schedule indicates that the program plans to complete 900 hours of operational test and evaluation (OT&E) prior to the LRIP decision. The tests include: Early User Test and Experimentation (EUT&E), Force Development Test and Experimentation (FDT&E), and an IOT&E. These tests are planned to be conducted using production-representative aircraft, with limited contractor involvement, and will simulate realistic combat situations in day, night and adverse weather conditions. [Ref. 22] They encompass the evaluation of operational effectiveness as well as operational suitability for operator, maintainer and support personnel.

In contrast to the Longbow Apache testing, the AH-64 Apache operational testing was not as comprehensive. The Apache operational testing consisted of 400 hours and was not conducted under realistic combat conditions. Additionally, production representative aircraft were not used. Instead, the operational test was performed on aircraft that included key subsystems that were planned to be redesigned after completion of the tests. The logistical support system was not tested because almost half of all Apache maintenance actions during operational testing were accomplished by the contractor or with contractor assistance. [Ref. 20] The intent of operational testing is to obtain results from a production representative article using typical operational personnel in a realistic combat environment. What the program called operational tests is by definition a developmental test.

4. Summary

Unlike the AH-64 which omitted an LRIP phase and follow-on operational testing, the Longbow Apache has incorporated an LRIP phase into the acquisition plan. The program office, which has planned to acquire 70 aircraft during this phase, expects to award one LRIP contract in November 1995 and a second in November 1996. During this time, the LRIP aircraft will undergo Early User Test and Experimentation, Force Development Test and Experimentation,

and an IOT&E. These test results should be ready prior to the full-rate production decision. This should provide an opportunity to carefully consider the status of the program and address any problems before proceeding with production.

The determination of the LRIP quantities was based almost entirely on the constraints of the 1994 POM build and the reductions in the TOA and RDTE accounts. Input from the contractor as to the desired quantities was, at best, minimally considered. The contractor should provide input into the quantity decisions primarily because he is responsible for establishing a production base and transitioning the aircraft from a development configuration into a production configuration. In the case of the Longbow Apache, McDonnell Douglas identified their minimum sustaining rate to be between 36 and 48. The final LRIP decision was between 12 and 24 aircraft less than the contractor's minimum requirements for the first lot. The second LRIP lot is more in line with the contractor's needs and may have been made just for that reason.

Given current world conditions, there seems to be less of a reason for the Apache Longbow to attempt any concurrent development. The existing threat poses no significant challenges and therefore the Longbow Apache program should progress as fast as technology allows. This is not to say that the program is immune from other challenges. With reduced procurement budgets, the Comanche helicopter poses a

significant threat to the Longbow Apache with respect to their similar missions and armament configurations. The second LRIP contract might be one tactic used by the program to reduce the chance of program termination.

C. OH-58D KIOWA WARRIOR

1. Program Status

The Kiowa Warrior is a modification of the OH-58D Army Helicopter Improvement Program (AHIP) helicopter. The modification of the OH-58A Kiowa to the OH-58D Kiowa Warrior has proceeded through four distinct phases: 1) basic OH-58D AHIP procurement from FY84-FY89, 2) congressionally directed provisioning for armed OH-58D procurements from FY89-FY91, 3) fully armed aircraft procurements (Kiowa Warrior) from FY92-FY93, and 4) the retrofit in FY92-FY95 of previously produced basic OH-58D AHIPs to OH-58D Kiowa Warrior aircraft.

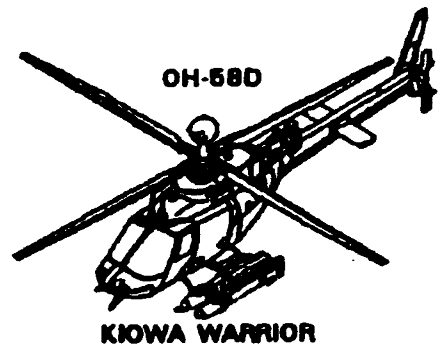

Figure 6 OH-58D Kiowa Warrior

The AHIP was an enhanced, upgraded version of the OH-58C observation helicopter. Its most prominent feature was the mast-mounted site system which protruded above the rotor hub. This mast-mounted site, which the Kiowa Warrior

retained, was designed to acquire, locate, and laser-designate targets day or night. It was able to obtain these features in obscured atmospheric conditions while remaining below the terrain mask. The mast mounted site was intended to minimize the exposure of the helicopter to enemy radar and electro-optical detection devices, and therefore was expected to enhance survivability.

The AHIP was designed to fulfill three battlefield roles. The roles were attack, air cavalry and field artillery aerial observer (FAAO). In the attack role, the AHIP would accompany the attack helicopters in a "hunter-killer" arrangement and would locate and designate targets for the attack helicopters laser guided Hellfire missiles.

In the air cavalry role, the AHIP provided an increased capability to rapidly reconnoiter and maintain surveillance over wide areas of the battlefield. They could operate independently or in conjunction with ground cavalry, or as part of a combined arms team.

In the field artillery aerial observer role, the AHIP provided an aerial platform from which to adjust fire of conventional and precision-guided munitions. The FAAO's mission was to conduct battlefield reconnaissance to gather target information in order to request and adjust indirect fires.

The OH-58D AHIP was developed in a single phase 42 month Engineering Development (ED) program under a contract

with Bell Helicopter Textron, Inc. (BHTI). The ED contract was awarded in September 1981 and a development effort started in November 1981. The mast-mounted site was subcontracted by BHTI to McDonnell Douglas Astronautics Co. BHTI was totally responsible for the overall system integration and system performance. The OH-58D program schedule is depicted at Figure 7.

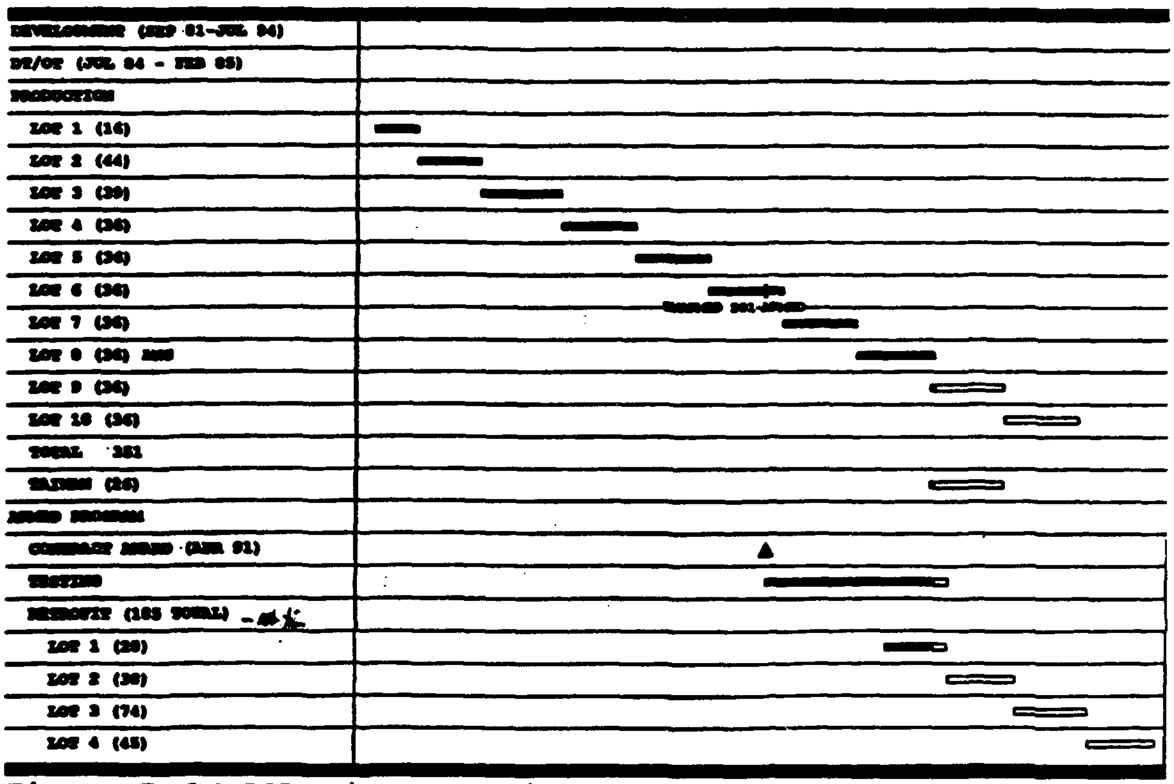

Figure 7 OH-58D Kiowa Warrior Program Schedule (Source: Kiowa Warrior Program Office)

The ED contract contained hardware ceiling prices (negotiated downward only) for the planned first and second year production quantities (16 in FY84, 44 in FY85). Retention of these ceiling prices was contingent on timely award of long lead and tooling contracts and award of full

production contracts by 1 October 1984 for the first lot and 1 October 1985 for the second. The quantities for the first two lots were established to provide a reasonable ramp up to a production rate of ten per month after three years. There was no discussion of LRIP until the Milestone III (DSARCIII) decision in October 1985.

According to the Program office personnel, there was concurrency in the program in that production Long Lead Time Items, Material and Effort (LLTIME) contracts and the first production lot contract were awarded prior to the completion of all Government testing. [Ref. 24] The LLTIME contract for Lot number one was awarded in July 1983, tooling and additional components and fabrication efforts were awarded in February 1984 after substantial contractor flight test, and the production contract was awarded 29 Sept 1984 after the Government Development Test (DTII) was completed. There was no operational testing completed before the production contract was awarded. LLTIME for lot number two was awarded in August 1984 after completion of the Government Preliminary Airworthiness Evaluation and the Production Readiness Review. These awards all took place before the Milestone III decisions. Formal DA level IPR's were conducted and DA approval was obtained prior to executing each award [Ref. 24].

There were 578 AHIPs originally planned for production. The Army obtained approval to buy only 179 after

the October 1985 Secretary of Defense Decision Memo (SDDM) which approved production for only one of the three roles. There had already been 135 aircraft bought when the Army attempted to terminate the program during its 1988 budget submission due primarily to budgetary considerations. Congress voted to restore funds to buy 36 more aircraft in FY 1988. In August 1989 the AHIP concluded an ASARC IV which approved funding for the armed OH-58D procurements. Table 3 indicates the program's milestone decision dates.

TABLE 3 OH-58D MILESTONE DATES

OH-58D	Initial	Current
Dem/Val Milestone I	Sept 1975	Sept 1975
EMD Milestone II	August 1982	August 1982
LRIP	N/A	N/A
Full Production Milestone III	October 1985	October 1985

(Source: OH-58D Kiowa Warrior Program Office)

2. LRIP Planning

The AHIP helicopter had no formal LRIP strategy. Since there was no formal strategy, no formal objectives were established. A representative from the program office described what the term LRIP meant to the program:

> LRIP for the AHIP was defined as producing enough aircraft to provide a reasonable ramp up to ten aircraft per month after three years of production and was used for

verification of production engineering, design maturity and the establishment of a production base [Ref. 24].

The first lot of 16 AHIP aircraft was planned to verify production engineering, design maturity and provide a sufficient quantity of aircraft to complete operational testing. The concerns with using the arbitrary number of 16 aircraft were twofold. First, the contractor was not involved in the determination of the lot sizes to verify production engineering. Secondly, the DOT&E was not involved in the determination of the required quantity of aircraft for testing.

The RFP requested a quotation for 24 aircraft for lot number one and 56 aircraft for lot number two. But the contract was for 16 aircraft in lot one and 44 aircraft in lot two because these quantities were within the available funding. [Ref. 24] This is another example of funding constraints driving decisions instead of proper program management decision making.

Since the Kiowa Warrior program was a modernization of a current air vehicle, the program objectives were to repackage and integrate available technologies into an existing airframe. But there were several low to moderate technology risks identified at the start of EMD. The first lot of Kiowa Warriors was planned as the designated LRIP articles with the intent of "proving out" the technology risks. The technology risks identified were mission equipment

and software integration, Mast Mounted Sight (MMS) vibration levels above the rotor system, MMS boresight accuracy and retention, engine certification schedule, and rotor dynamics of the composite main rotor and hub system. [Ref. 24] An October 12, 1993 memorandum from the DUSA(OR) to the DOT&E indicated the request for a full material release for the Kiowa Warrior was pending the results of additional testing. The specific reasons cited were "that the autorotational characteristics were unsatisfactory using the approved techniques and the engine surges during rocket firing" [Ref. 25]. Not surprisingly, these were two of the five technology risks identified by the program office.

3. Testing

There were two operational tests performed on the AHIP aircraft. The first test compared the AHIP to the OH-58C. The objective was to test the AHIP in all three of the roles for which it was designed. A Beyond LRIP report, written at the conclusion of the operational test, concluded that as tested, the AHIP demonstrated an operationally effective capability in only one of the three roles planned for it (FAAO). [Ref. 26] The DOT&E recommended that only a conditional approval of limited production be authorized. Based primarily on this assessment, a decision was made to procure AHIPs only for the FAAO role. This meant that only 179 of the originally planned 578 AHIPs were approved for

production. Had this report not been made on that first production lot, the Army might have incurred expensive retrofit costs or produced aircraft that could not perform their intended missions.

The second operational test was the AHIP Follow-On Test and Evaluation (FOT&E). But before the test was conducted, the Army cancelled production funds for any new AHIPs. As a result, a new test objective was established and the test was redesignated the Army Aerial Scout Test (AAST) [Ref. 26]. The objective of the test was to compare alternative candidate systems to the baseline AHIP. The alternative candidates included the OH-58C, the OH-58C+ (OH-58C with infrared sensors), AH-1S Cobra (modernized), and the AH-64 Apache.

Initially, both air cavalry and attack roles were supposed to be tested, but only the air cavalry phase was conducted. The results of this test indicated that the AHIP was superior in locating enemy targets over all other scout candidates. The test results were intended to refute the DOT&E's claim that the AHIP could not perform all of its intended missions.

The Kiowa Warrior evaluation concept involves incorporating the previous operational and technical data results of the OH-58 AHIP germane to the Kiowa Warrior's operational performance. This is planned to be accomplished utilizing two FDTEs at Ft. Bragg and Ft. Hood. They will

evaluate both operational effectiveness and operational suitability using critical operational issues (COIs). Production and conditional fielding are in progress. The results of the FDTE's should insure a full materiel release.

4. **Summary**

There was no formal LRIP strategy for the program. Since the Kiowa Warrior technology advances were considered evolutionary as opposed to revolutionary, the program office chose not to include an LRIP phase. LRIP in this program meant producing sufficient aircraft to provide a reasonable ramp up for production. As a streamlining measure, a production authorization resulted from the ASARCII decision.

There were only 16 aircraft in the first lot and 44 in the second due to economic considerations and the desire to have a reasonable ramp up to a production rate of ten per month after three years. The original plan was for 24 in the first lot and 56 in the second. The contractor was not involved in the final decision even though he is responsible for establishing the production base.

Only developmental testing was completed prior to the first production lot of AHIPs. Operational testing was completed sometime later. The testing community had no say as to the number of aircraft required to support OT II. The Kiowa Warrior evaluation issues that can not be evaluated

using previous operational and technical data are anticipated to be adequately addressed during the two FDTEs.

D. MH-47 & MH-60 SPECIAL OPERATIONS AIRCRAFT

1. Program Status

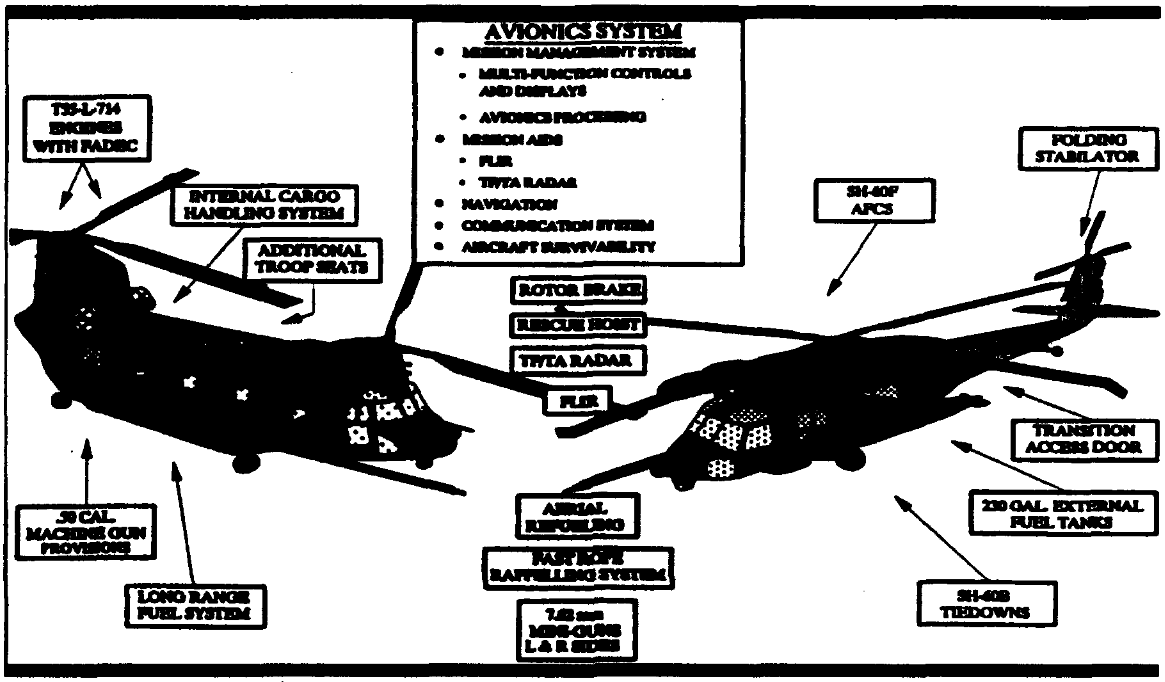

Figure 8 SOF Aircraft

The Army initiated the Special Operations Forces (SOF) modification for the CH-47 Chinook and UH-60 Blackhawk helicopters in 1986. This was in response to a DoD Special Operations Forces Aircraft Report and a Special Operations Expedite Essential Required Operational Capability (EEROC) document. The program was officially established on 4 April 1986 and was based on a streamlined, Non-Major Acquisition Category III, Non-Development Item Category III (some R&D), Limited Procurement Urgent criteria [Ref. 29]. Table 4

indicates the initial and most current program milestone dates.

TABLE 4 SOF MILESTONE DATES

SOF	Initial	Current
Program Initiation	April 1986	HQDA Message
Dem/Val Milestone I	November 1987	November 1987
EMD Milestone II	November 1987	November 1987
LRIP Milestone IIIa	Not Planned	February 1990
Full Production Milestone III	February 1990	August 1991

(Source: SOA Program Office)

This strategy included significant internal and external program dependencies along with concurrent prototyping and production. A few of the dependencies included conversion of the CH-47C to CH-47D (required prior to MH-47E conversion), modification of the T-712 engine to provide 20 percent more horsepower and the 230 gallon external fuel tank for the MH-60K. Because of the cancellation of some of the dependent DoD programs, which increased the Special Operations Aircraft (SOA) program costs above the ACAT III threshold of $75M R&D/$300M production, the program was designated an ACAT II [Ref. 27].

The Program provides 26 MH-47E and 23 MH-60K for the United States Special Operations Command (USSOCOM) and, in

particular, for the Army's 160th Special Operations Aviation Regiment, (SOAR) Airborne. The SOA Program modifies Army CH-47D and UH-60K helicopters to perform clandestine, deep penetration airlift missions in adverse weather, with limited lighting and visibility during night or day conditions, over all types of terrain [Ref. 28]. Typical SOF targets include, but are not limited to, nuclear delivery systems, C^3 facilities, logistic centers, and key structures such as bridges and railroads [Ref. 28].

A Government competitive selection was made for the Integrated Avionics Subsystem (IAS) which constituted the single most significant portion of the program. The aircraft development and qualification efforts were then obtained through engineering change proposals (ECPs) to the existing aircraft multi-year contracts with the aircraft manufacturers. The major responsibility for the management and execution of the program is placed with the prime contractors who have Total System Performance Responsibility (TSPR). This TSPR means that the airframe prime contractors (Boeing Helicopter and Sikorsky Aircraft) have the responsibility for the performance of the total system which includes the airframe and the Mission Equipment Package (MEP) [Ref. 29].

The sought after SOA technology is based on four primary functions that must be integrated together to ensure program success. The first two consist of upgrading the existing CH-47D and UH-60L airframes and the T55-L-714 engine

for 20 percent more horsepower while inserting the latest technology Full Authority Digital Electronic Control. The third function is to adapt the latest technology digital Integrated Avionics Subsystem with advanced Terrain Following/Avoidance Radar and FLIR. The fourth function is inserting the latest technology SOF mission equipment packages such as air-to-air refueling, range extension kits, and mini-guns [Ref. 27]. The overall program is about one year behind schedule because of the event driven decision process rather than the classical calendar approach.

2. LRIP Planning

The SOA program entered LRIP because the production base for the conversion of the CH-47C to the CH-47D, which provides the input configuration to the MH-47E, was going to terminate, and the requisites for a full production decision were not complete [Ref. 27]. Additionally, since all the classical Milestone II elements had not been completed by the scheduled Milestone III decision point, a Milestone IIIa was injected to authorize LRIP for the first 11 aircraft of each type. At the same time, the authorization for long leadtime procurement was made for the remainder of the fleet. Had the decision not been made to start limited production, the schedule would have been extended two years and costs would have increased by $50M [Ref. 27].

A second LRIP decision was made at Milestone III based on the successful completion of some technical tests, logistics demonstrations and the desire to avoid a break in the production line. The additional LRIP quantities included the entire MH-60K (11 additional) requirement and an additional 14 MH-47E (25 total) aircraft. A program management official commenting on the rationale for utilizing a second LRIP decision, which produced almost the entire planned production amount, stated, "considering the facts that such a limited fleet, for an urgently needed capability, for a single user, was involved, this became an obvious decision" [Ref. 27].

The one thing that was obvious was the fact that the requisites for full production were not, or could not be met, and the program management office intended to field the system using LRIP. The SOA program office believes that the most important aspects of the LRIP approach are to control risks and exposure while maintaining program continuity and minimizing costs.

The initial LRIP quantities were based on training, testing and production continuity considerations. The contractors were involved to the extent of providing information on manpower and facility loading and cost impacts of various alternatives. The second LRIP quantities were based on production continuity, fleet size, and funding availability. The PEO Aviation made the initial decision for

LRIP. The second LRIP decision was made by the PEO with the knowledge and consent of the Army Acquisition Executive (AAE) and the User. Figures 9 and 10 show the milestones and the developmental and operational testing schedules.

3. Testing

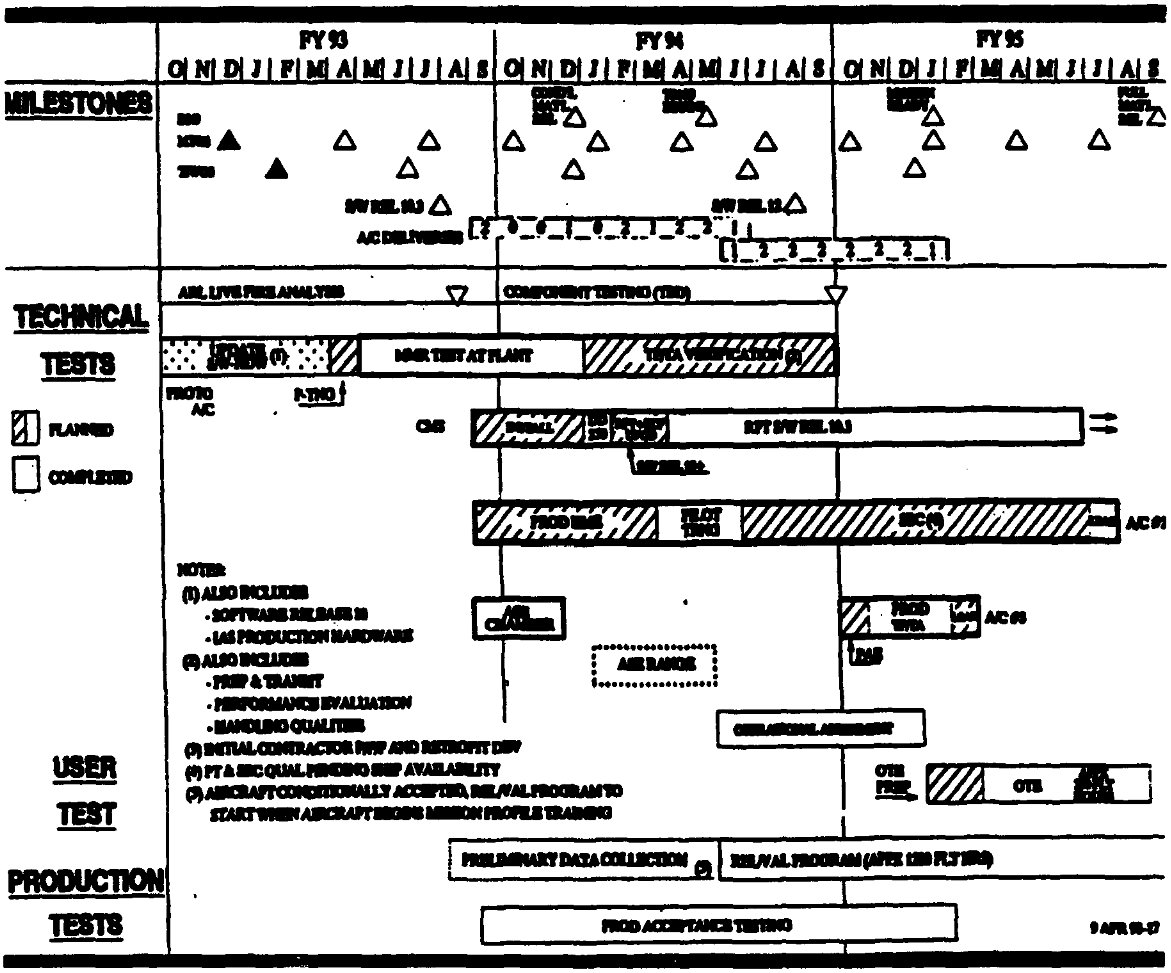

Figure 9 MH-47E Program Schedule (Source: SOA Program Office)

Originally, the Army decided that since the modifications of the helicopters were considered non-development items, it would perform little developmental and no operational testing. This decision was based on the

premise that the helicopters used were already qualified systems and the planned testing and evaluation would consist of integrating and testing already qualified components [Ref. 30]. However, based on discussions with the DOT&E, it was decided that the acquisition and testing strategies for both helicopters should be restructured to include additional development and operational testing.

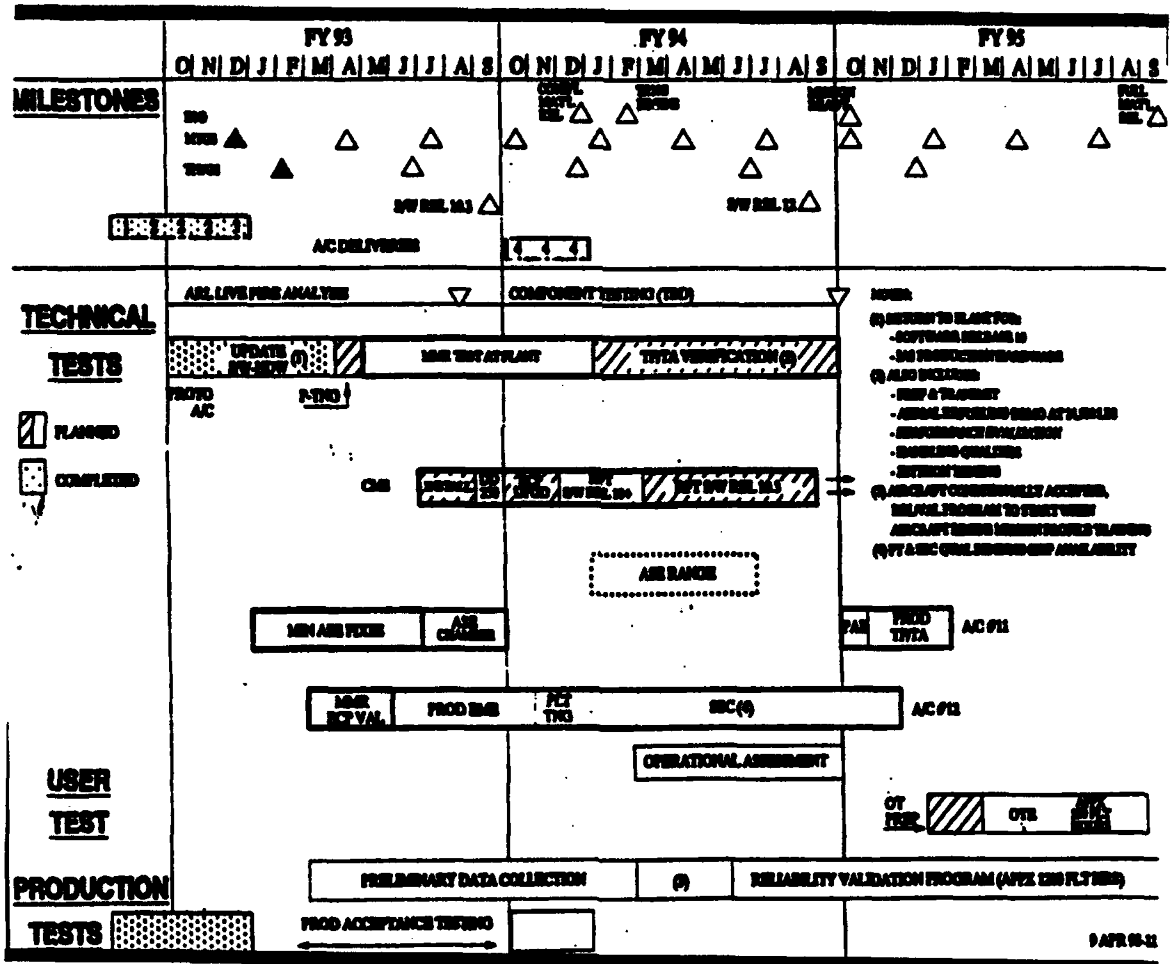

Figure 10 MH-60K Program Schedule (Source: SOA Program Office)

The schedules indicate that prototypes of both the MH-47E and the MH-60K were returned to the plant for a software

update and Integrated Avionics Subsystems production hardware. The technical tests associated with this integration were completed in March 1993. Additionally, the testing schedule indicates that the SOA aircraft have a complete array of production, technical and operational tests planned into the program. There is a 50 hour preliminary assessment (Phase 1) designed to look at operational effectiveness and suitability of the aircraft in realistic operational environments. The intent is to determine the potential for the system to satisfy critical operational issues (COIs).

Following this is an operational assessment (Phase II) which is a detailed assessment of the operational effectiveness and suitability for use by typical users in realistic operational environments. The intent of this assessment is to determine the degree to which the system's COIs have been satisfied. Unfortunately, the operational testing will be accomplished after the production decision is made so any problems encountered and required fixes will not be addressed.

4. Summary

The Special Operations Aircraft program office employed LRIP as a method of shortening the acquisition cycle for a relatively small production run. This was accomplished because the acquisition regulations never envisioned the concurrent acquisition for such a specialized limited quantity

of end items. The primary reason the SOA program entered LRIP was to ensure there was no break in the production line. Since the requirements for full production had not been achieved, LRIP was inserted to bridge the gap. Had this not been used, the program would have slipped two years and increased in cost approximately $50M.

The PEO, PM and User selected the quantities for the LRIP phases. Contractors were involved only for cost analysis of various alternatives. The testing community had little input into the quantity decision. The initial and extended LRIP quantities were primarily based on production continuity and funding considerations.

Operational testing is being accomplished to ensure the system functions as intended. One problem noticed with the operational testing strategy is that a large percentage of the aircraft have already been awarded the production decision via two LRIP awards prior to the results of the testing.

E. RAH-66 COMANCHE

1. Program Status

The RAH-66 Comanche is envisioned to be a lightweight, twin engine, advanced technology helicopter that will replace the Army's current light helicopter fleet. The current light fleet includes the AH-1 Cobra, the OH-6 Cayuse, and the OH-58A/C Kiowa helicopters. The Comanche will perform armed reconnaissance and attack missions in the close, deep and rear

battle environments. Air combat operations will be an inherent capability and the Comanche will be equally effective on the linear and non-linear battlefield across the operational continuum [Ref. 31].

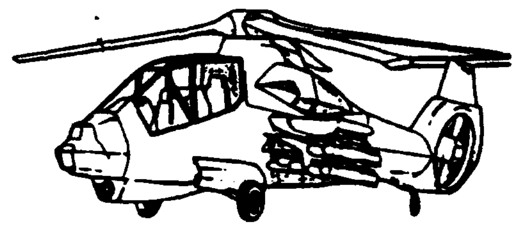

Figure 11 RAH-66 Comanche

The Comanche is intended to correct major light fleet deficiencies such as marginal night and adverse weather capability, location/navigation inaccuracies, and inability to self-deploy to overseas theaters. Comanche system improvements will include lightweight composite airframe structures, protected anti-torque systems, high-reliability rotor systems, reduced signature, and built-in diagnostics/ prognostics [Ref. 31].

Concept Exploration was initiated with preliminary study efforts in 1983. These efforts provided the necessary technical information and confidence required to verify concept feasibility and define the system's operational requirements. Competitive preliminary design contracts were awarded to Bell Helicopter Textron, Boeing/Vertol (now Boeing Helicopters), Hughes Helicopters (now McDonnell Douglas Helicopter Co), and Sikorsky Aircraft in September 1983. These studies included investigation of concepts and designs

of derivative helicopters, advanced technology conventional helicopters, and other various advanced helicopters [Ref. 31].

Competitive Dem/Val contracts were awarded to the Boeing/Sikorsky and the McDonnell/Bell contractor teams in November 1988. The focus of the initial competitive Dem/Val phase was to define the Mission Equipment Package (MEP) and electronics architecture; demonstrate performance of key MEP components with brassboard and breadboard hardware; and define performance requirements for a lightweight helicopter through design analyses and selected demonstrations [Ref. 31]. Table 5 indicates the initial and most current schedule estimates for the program milestones.

TABLE 5 COMANCHE MILESTONE DATES

Comanche	Initial	Current
Program Initiation	June 1983	JMSNS
Dem/Val Milestone I	December 1988	April 1991
EMD Milestone II	January 1991	November 1997
LRIP Milestone IIIa	November 1994	September 2000
Full Production Milestone III	November 1996	November 2002

(Source: Comanche Program Office)

The Dem/Val phase Source Selection Plan (SSP) was approved by the Source Selection Authority (SSA) on 23 April

1990 and the request for proposal (RFP) was released on 1 May 1990. Proposals were received from both industry teams on 31 August 1990. After months of proposal evaluations and negotiations, Boeing/Sikorsky was announced as the winning contractor team on 5 April 1992.

The Comanche is currently being developed as an ACAT 1D program. The development program consists of an extended Dem/Val Prototype phase (78 months versus 54 months) as required by Department of Defense budget constraints. The primary objectives of the Dem/Val Prototype phase are to complete the aircraft design, build prototype aircraft, and conduct a flight test program to reduce risk and demonstrate that the system is ready to continue development.

The DoD budget constraints are a result of the January 1992 funding restrictions instituted by the President's FY 93 budget. The SECDEF directed the Comanche program to submit a plan to restructure its development contracts to prove out all critical components, including avionics, an upgraded T800 engine, and the Longbow radar system within available funding. The resubmitted plan included extending the Dem/Val Prototype phase an additional two years and reductions in the number of prototype aircraft built. Figure 12 shows the original program schedule as well as the restructured schedule. Because of the deferral of EMD and production, there may no longer be any contractor commitments for production performance.

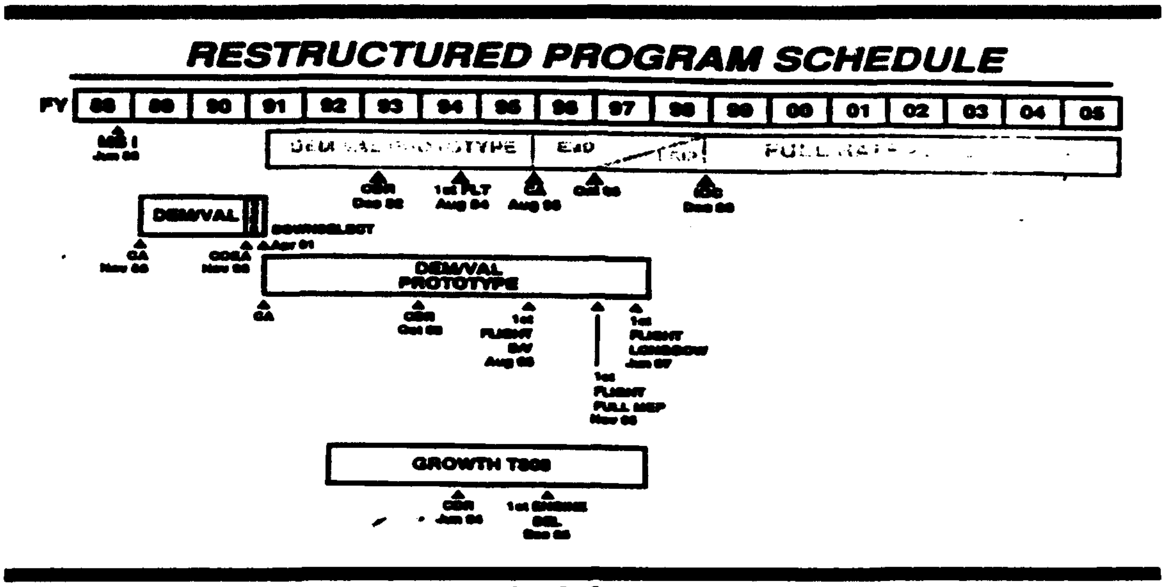

Figure 12 RAH-66 Program Schedule (Source: Comanche Program Office)

Should a decision be made in the future to proceed beyond Dem/Val, an EMD phase of approximately 48 months would be required prior to entering production. The total production buy is currently planned at between 1681 and 1292 helicopters.

It is obvious, by the extension of the Dem/Val prototype phase, that the risk reduction effort is very important to the program. The Comanche faces many development challenges. According to the Deputy Program Manager, the most difficult technical challenges in the overall Comanche development program will be meeting the Low Observable (LO) requirements, integrating the MEP into the aircraft, achieving mandated cost and weight requirements, and software integration [Ref. 32]. In meeting these challenges, the Comanche Program has planned an LRIP strategy designed to

provide an early chance to evaluate production configuration aircraft to insure they provide the required capabilities prior to full rate production.

2. LRIP Planning

The Comanche program has planned to use an LRIP strategy since its inception. Through the use of LRIP, both the producibility of the Comanche and its production representative performance can be validated prior to the MS III decision.

The objectives of the Comanche LRIP program are in conformity with the DoD instructions. The program plans to enter LRIP to demonstrate that the production processes and techniques are capable of producing aircraft at the required rate and level of quality. Secondly, it provides production representative aircraft to be used for completion of development activities, critical operational assessments, and validation of logistics concepts. Thirdly, it validates the producible quality of the Comanche design.

The quantity of LRIP aircraft was determined by the Program Manager, the AAE and the DUSA(OR) (at the time of the decision, the program was reporting directly to the AAE and was not under the PEO structure) According to the Deputy Program Manager, 48 aircraft will be built as LRIP articles, 24 per year, for two years, at a production rate of two per month [Ref. 32]. This quantity was chosen in order to provide

eight production representative aircraft for IOT&E. The contractor was involved from the standpoint of how and when LRIP would be implemented to provide for a smooth transition into production, but was not involved in any quantity decisions.

The Comanche Program has undergone many changes since program inception. During the 1988 restructure, the LRIP decision was scheduled for November 1994, almost two years before the EMD phase was scheduled to be completed. This would have resulted in less accurate information from which to make a proper LRIP decision. All this has now changed as a result of the 1992 restructure in that an LRIP decision is not scheduled to be made until after EMD. Currently, the Program is undergoing another streamlining effort. The results of this effort may again change the LRIP strategy.

Preliminary results of the Comanche streamline effort indicate that a production long lead authorization and an LRIP decision are planned for November 1998. The LRIP quantities were reduced from 48 to 12. This again is a funding decision since the program is selling the streamlined acquisition strategy as "efficiencies resulting in RDT&E and procurement savings" [Ref. 33].

3. Testing

According to the Comanche Test and Evaluation Master Plan, the primary purposes of OT&E are to ensure that the

Comanche is operationally effective and operationally suitable, and that it meets the mission needs and minimum operational performance requirements of the operating forces [Ref. 34]. To accomplish this, the Comanche test program encompasses a variety of efforts designed to reduce the user's concern.

During the Concept Exploration phase, user involvement was incorporated into the Advanced Rotorcraft Technology Integration (ARTI) program. A team of four US Army Forces Command (FORSCOM) and US Army Aviation Center (USAAVNC) pilots were made available to support the Comanche (at the time it was known as the LHX) cockpit simulations and flight testing. [Ref. 34]

A second segment of user participation was the Simulation Assessment Team (SAT). The SAT provided a group of suitably qualified pilots to further compare the contractors' simulation against a common standard. A Government Composite Mission Scenario (GCMS) was designed and used as the common standard. The SAT visited each contractor facility and reviewed the adequacy of each contractor's simulation to validate their workload and equipment analysis. [Ref. 34] There were no formal operational assessments or evaluations conducted, but operational-like data were collected and reported to the SSEB.

During the initial Dem/Val phase, the testing focused primarily on the development and integration of the MEP and

the electronics systems architecture. The intent was for early identification, isolation and reduction system technical risk by hardware demonstration and progressive system integration.

The Dem/Val prototype phase has the Comanche incorporating the Longbow radar system and an upgraded T800 engine. The test program will utilize three prototype aircraft and will entail a Government/contractor combined test team approach. This approach is designed to ensure the demonstration of critical technologies and that airworthiness and structural test requirements are met. [Ref. 31] As currently envisioned, once approval is received to enter the EMD phase, three additional prototype aircraft will be built and tested.

As for the future, the Army plans to conduct a series of tests and experiments in support of the development effort. The Training and Doctrine Command (TRADOC) and the Test and Experimentation Command (TEXCOM) will use the Early Operational Capability (EOC) unit to conduct a series of three Force Development Test and Experimentations (FDTEs) [Ref. 34]. FDTE I will explore existing armed reconnaissance and attack tactics in a variety of Comanche mission scenarios. FDTE II will evaluate selected tactics, techniques and procedures (TTPs) from FDTE I to emphasize team tactics. FDTE III will be a force-on-force, networked combined arms exercise to assess the effectiveness of the previously developed Comanche

TTPs. Due to system immaturity, these operational assessments are not planned to support an LRIP decision but will focus on mission performance functions such as target detection, acquisition, location, and reporting [Ref. 32].

The currently planned EMD phase will conclude with the conduct of an IOT&E of approximately 90 days and 750-1200 flight hours [Ref. 34]. TEXCOM will conduct the test with EOC personnel flying and maintaining LRIP aircraft. The resulting data will support the Milestone III Production decision. The preliminary streamlining effort indicates that four prototype aircraft will complete flight testing between November 1995 and January 2001. There is currently no available information of the type of operational testing planned for the new streamlined LRIP aircraft.

4. Summary

Because the Comanche is considered to be a major innovative technological system, the acquisition strategy incorporated the use of an LRIP phase. The LRIP strategy and the program's planned implementation of it was in conformity with the DoD instructions.

DoD Instruction 5000.2 requires that LRIP quantities be limited to certain criteria. This guidance provides a great deal of latitude to the program office in determining their LRIP quantity. In the case of the Comanche, the quantity of LRIP aircraft planned has been the same even

though the total production buy has decreased. When the LRIP quantities were established, the total production was 2,096. In 1991 the production number was reduced to between 1,641 and 1,292 aircraft. Preliminary data available on the streamlining of the Comanche suggest a reduction in the LRIP quantities. As with the previous systems, the contractors were not involved in the determination of the final LRIP quantities but instead, from the standpoint of how and when LRIP should be implemented. As a result of the Comanche streamlining effort, the total LRIP quantities were reduced to 12 aircraft. Primary reasons for the reduction were to keep the program dollars within cost constraints.

The testing program for the Comanche is extensive. During the restructure, the number of prototypes available for tests was reduced from six to three, but the hours dedicated for those tests increased. This seems to affirm that the program intends to reduce as much as possible the inherent risks of a new system before production. As a result of streamlining, the number of prototypes was increased from three to four with no increase in dedicated test hours.

The operational assessments will utilize the Early Operational Capability unit to explore tactics in a variety of Comanche missions. Early user involvement should assist the engineers and MANPRINT personnel in designing the system for ease of use.

V. ANALYSIS

A. INTRODUCTION

The use of Low Rate Initial Production as part of any acquisition strategy can provide many benefits if properly planned and implemented. The research indicates that although regulations and the guidance concerning LRIP are provided to program managers, they are at best vague and confusing.

This chapter will present an analysis of significant issues based upon a review of DoD's acquisition policies and the investigation of the selected Army Aviation systems.

B. SIGNIFICANT ISSUES

1. A Change in the Current Acquisition Culture

When the Cold War ended, it brought to a close almost 45 years of a national security policy dominated by the threat posed by a communist regime. The acquisition culture was that of threat driven requirements. Once a perceived enemy's new system was discovered, our policy dictated that we produce something bigger, faster and better. Along with those requirements, the system needed to be fielded with the utmost urgency. After the threat driven requirements were aggregated into force structure scenarios, Operational Requirements Documents were developed.

This threat driven paradigm is now gone. No longer can we base system development on an impending threat and utilize high risk strategies such as concurrency. The acquisition strategy for the AH-64 Apache illustrated this point, featuring an accelerated development schedule and no incorporation of an LRIP phase. A paradigm shift away from a threat driven scenario and into more of a goal oriented scenario is needed.

A second reason for change results from the current practice of penalizing program managers for exhibiting integrity. When technical problems are encountered and reported during development of a high risk system, the program is in jeopardy of termination. Program managers are placed in a situation of conflicting requirements. On the one hand, they must be champions of the cause, defending their programs from critics and adversaries.

On the other hand, they are guardians of trust and must be truthful in assessing the risks of their programs, even to the program's detriment. This can lead to reduced testing, providing meaningless and easily attainable exit criteria, or the procurement of much larger quantities of LRIP articles than are truly necessary.

Additionally, problems encountered early in a development phase can give critics ample ammunition with which to "shoot down" the program. Critics often forget that high-tech programs are not without risk.

Two of the four programs reviewed displayed symptoms of the prevailing acquisition culture. The Comanche program has been restructured, reshuffled, and reprogrammed because of risk. One program response is to plan on producing 48 LRIP articles to ensure that eight are available for IOT&E. This seems to be an excessive amount, but not unrealistic considering the current culture. The SOA program plans to produce more than three quarters of its total buy as LRIP articles. Again, this is a much larger amount than required to meet the criteria established by DoD Instruction 5000.2. Some officials believe that if enough systems are produced early, the inertia alone will keep production going. Although most economists believe that sunk costs are irrelevant when deciding whether to continue spending money, many politicians believe the contrary. As long as this paradigm exists, programs will continue to use tactics that run counter to the intent of regulations. The acquisition process can no longer sustain an environment which cultivates conflicting requirements.

2. LRIP Oversight

The revised DoD Directive 5000.1 and the implementing DoD Instruction 5000.2 do not provide adequate oversight regarding the minimum program accomplishments needed before proceeding into LRIP. There is limited oversight to ensure a stable design or production readiness. Additionally, the

programs themselves decide what exit criteria if any, need to be demonstrated in order to proceed with an LRIP. The exit criteria for decision points are suggested but not required by DoD Instruction 5000.2.

Specifically, DoD Instruction 5000.2 fails to provide oversight on these important considerations:

- Minimum program accomplishments required before entering LRIP to ensure a stable design exists, test results support proceeding with the production decision and readiness for production has been confirmed;
- Establishment of program specific exit criteria for initiation of long lead funding for LRIP, entry into LRIP and award of subsequent production lots; and
- Milestone decision authority reviews of program status and accomplishments, including reaffirmation of the LRIP quantities and acquisition strategy before entering LRIP [Ref. 15].

DoD Instruction 5000.2 provides little guidance on determining the appropriate amount of articles designated as LRIP. The guidance indicates that LRIP quantities should be limited to the minimum required for IOT&E, to establish an initial production base and to permit an orderly increase in the production rate sufficient to lead to full-rate production. There is no formal guideline concerning the acceptable LRIP quantity versus the total planned production quantities. This guidance is very broad and it allows programs the flexibility to decide on an amount which may be based on factors unrelated to the DoD regulations or their intent. Bounds should be established to assist program

managers when determining an appropriate number of LRIP articles.

The SOA program is a good example of this deficiency. An LRIP decision was established only to keep the production line open. The SOA program entered LRIP because the production base for the conversion of the CH-47C to the CH-47D, which provides the input configuration to the MH-47E, was going to terminate and the requisites for a full production decision were not complete.

The Apache program entered operational testing with intended design changes on its LRIP aircraft (Lot one). Production representative aircraft were not used. Instead, the operational test was performed with aircraft which included key subsystems that were planned to be redesigned after completion of the tests. While additional oversight for LRIP will not substitute for sound program management, the level of oversight does affect the focus of program management.

3. Contractor and Test Communities Involvement in Determining LRIP Quantities

As previously mentioned, the guidance indicates that LRIP quantities should be limited to the minimum required for IOT&E, to establish an initial production base and to permit an orderly increase in the production rate sufficient to lead to full-rate production. In the Longbow Apache, OH-58D Kiowa

Warrior and the SOA programs, the determination of the number of LRIP articles was based strictly on budget considerations. Contractor participation was limited to cost analysis and LRIP timing decisions. In the case of the SOA program, the quantities were based primarily on production line continuity and there was little involvement from the testing community. In only one case, the OH-58D, was the testing community involved in the quantity determination. Ironically, this was the only program that did not have an LRIP strategy as part of its acquisition strategy. Since the contractor is responsible for two of the three LRIP quantity determination factors, more involvement is justified.

4. LRIP Phasing Effects on Program Costs

An aspect of increased costs arises when the use of LRIP defers the unit production costs to later years when inflation, labor rates and overhead rates are higher. Additionally, LRIP permits the opportunity for Follow-on Test and Experimentation which delays the full-rate production decision. This again results in higher unit costs and ultimately higher total program costs.

The Longbow Apache program was impacted not by the decision to have an LRIP but when to conduct it. The Longbow Apache LRIP decision is scheduled one year after the DAB approval and has, according to the Product Manager, significantly increased costs for the three program contracts.

The SOA program faced different circumstances regarding LRIP and cost increases. Since LRIP was not a planned strategy from the outset, but only incorporated to keep the production line operating until all production requirements were met, the use of LRIP saved the program money. Had the decision been made not to start LRIP and the production line shut down, the schedule would have been extended two years and the costs would have increased by $50M. In terms of costs, LRIP may be construed as a "double edged sword".

5. Completion of Initial Testing

Testing programs are designed to provide the decision makers with the data necessary to make intelligent and informed decisions. It is imperative that both development and operational testing be complete prior to making an LRIP decision. Making production decisions prior to the completion of testing has the potential for disastrous consequences.

In the case of the OH-58D, only development testing was accomplished prior to the decision to proceed with production lot one. When operational testing was completed, the results indicated that the aircraft had demonstrated an operationally effective capability in only one of the three mission roles planned. As a result, the DOT&E only recommended production for the FAAO role.

The SOA strategy indicates that the program plans production concurrent with developmental testing and before operational testing. This concurrency is considered feasible by the program office because the upgrades are only modifications of previously fielded systems. It is considered more of an NDI strategy than a new development program.

The Longbow Apache testing program is more comprehensive than the AH-64 Apache. The testing program indicates the Longbow Apache will conduct initial operational testing prior to the LRIP decision using production representative aircraft. In contrast, the Apache operational testing did not utilize production representative aircraft and was not conducted in a realistic environment. LRIP decisions made prior to the completion of testing can significantly increase the risk of large retrofit costs should a system not meet its operational requirements.

6. Concurrent Development and Production

Current acquisition policies can result in a void between phases in the acquisition cycle. The void is most pronounced between the development and production phases because production should not be initiated until all engineering is reasonably complete and all significant design problems have been identified with corresponding solutions.

Concurrent acquisition strategies, if accomplished effectively, have the potential to save time and money.

Unfortunately, the converse is true when too much concurrency is planned and entry into LRIP is premature. The results are usually expensive retrofits and fielding delays as was the case with the AH-64 Apache. When programs adhere to an orderly and sequential design, test and evaluation, and a clear separation of development and production, many benefits may accrue. One such benefit is that it bounds the Government's risk by preventing the initiation of a costly manufacturing program before all engineering problems are solved and the design is proven.

The AH-64 Apache provides a good example of why concurrency should be avoided. The strategy of concurrency allowed it to entered production with an immature design and with a logistic support concept that could not be demonstrated. This decision cost the Government in terms of low availability rates and expensive retrofits.

Reducing concurrency allows the time for incorporation of required changes that surface as a result of development and operational testing. The OH-58 provides insight into this area. An argument can be made that had the OH-58 AHIP program been slowed down and an LRIP phase incorporated, the need to retrofit AHIPs into Kiowa Warriors may have been averted. The fact that only developmental testing was completed prior to the first production lot indicates that the program had no intention of relying on the results of operational testing which might have indicated the requirement to be fully armed.

Reducing concurrency can also be seen as an attempt to improve the predictability of cost, schedule and performance factors. It presents a more conservative face to the Congress which must approve commitment of funds for system production. All of the aviation systems analyzed can benefit from this, but the Comanche program offers the best example.

The program has undergone many changes since program inception. As a result of the 1992 restructure, all production funds were withdrawn from the program and the Dem/Val phase was extended two additional years in order to reduce risk. As recently as the December 1993 streamlining effort, some production funding has been restored to the program which indicates confidence that some of the high risk has been mitigated.

It would be naive to believe that allowing for a planned production gap would be the answer to all acquisition problems. There are some potential impacts that might negatively affect a program.

As mentioned earlier, during periods when there is a high rate of inflation, a long gap would severely escalate the costs of a system. Depending on whether the program is evolutionary as opposed to revolutionary (Comanche versus Kiowa Warrior), a cost benefit analysis might indicate concurrency as the optimal solution. A second and more political reason is that delaying production invites critics

to converge upon the program and increases the possibility of program termination.

7. Affordability Considerations on LRIP Quantity Decisions

Funding constraints seem to be the primary consideration used when program offices establish the quantity of aircraft desired for LRIP. It appears that political concerns provide the rationale when determining a viable quantity for LRIP. Even programs that abide by the DoD guidance in establishing the quantities of LRIP articles are not shielded from the budget axe.

According to the Apache Program office, the initial production quantity was based solely on affordability considerations. There were 15 aircraft planned as the initial production quantity but the number was reduced to 11 based upon a "Should Cost" determination of available funds and subsequent negotiations with the prime contractor.

Information obtained from the Longbow Apache program office indicated that 24 aircraft were planned for LRIP with a contract award scheduled for November 1995. This number was established in June 1992 and derived from budget/POM drills and the reductions in the Army's Total Obligation Authority (TOA). Both the PM and contractor preferred a larger number ranging between 36 and 48 in order to meet the contractor's established minimum sustaining rate.

The OH-58D Kiowa Warrior program offers another example of funding constraints driving decisions instead of proper program management decision making. The initial request was for 24 aircraft for lot number one and 56 aircraft for lot number two. The resultant contract was for 16 aircraft in lot one and 44 aircraft in lot two because these quantities were within the available funding lines.

Only the SOA program's initial LRIP quantities were based on training, testing and production continuity considerations. The second LRIP quantities were based on production continuity, fleet size, and funding availability.

The Comanche program offers the final example of budget constraints. The LRIP quantities were reduced from 48 to 12 base upon the preliminary streamlined strategy. This is believed to be a funding decision since the program is selling the streamlined acquisition strategy as "efficiencies" resulting in RDT&E and procurement savings. Funding constraints should be part of the program management decision making process, not a replacement for it.

C. SUMMARY

This chapter provided an analysis of significant issues which were both DoD programmatic as well as aviation system peculiar. The issues span the spectrum from general acquisition reform, in which cultural transformation is needed, to inadequate oversight when planning for LRIP and

identification of the strengths and weaknesses of acquisition strategies. The issues were chosen because of their direct correlation with all or most of the systems analyzed.

The following chapter will derive conclusions from the analysis and provide recommendations to remedy some of the more prominent problems. A suggestion of areas for further research will follow the recommendations.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. General Conclusion

Low Rate Initial Production, as it is currently being implemented, is not ensuring that the risks of transitioning from development to production are adequately addressed. To minimize the risks of transitioning from development to LRIP in a non-threat driven environment, several prerequisites should be met. These prerequisites include: minimizing as much as possible any unresolved deficiencies resulting from development testing, ensuring the successful completion of operational testing on production representative articles and basing LRIP decisions on systems with a mature design. Prototype systems may be used as LRIP articles provided they represent the final aircraft configuration.

LRIP, in most cases, is being used to secure a production commitment. Some aviation systems are entering LRIP before they are ready, utilizing multiple LRIP awards to keep production lines open. With changing threat conditions and decreased defense dollars, total aircraft buys are being reduced. The combination of multiple LRIP production awards and the reduced overall buys increases the risk of over commitment to production.

DoD Instruction 5000.2 is not specific when addressing the quantities necessary for initial operational test and evaluation, establishment of a production base, or an orderly increase to a full-rate production. Furthermore, 5000.2 is vague regarding the requirements necessary for entry into LRIP. This escalates the potential for abuse of the intent of LRIP and again increases the risk of over commitment to production.

2. Specific Conclusions

Funding constraints and test articles are the major LRIP quantity determinants. In all cases analyzed, funding decisions drove the number of LRIP articles. These funding decisions took into account the required number of systems for operational testing but not for the establishment of a production base or an orderly increase to full rate production. This was evident by the lack of contractor involvement in the final LRIP quantity decision.

Premature entry into LRIP is a systemic deficiency in acquisition oversight. Present guidance provided by DoD Instruction 5000.2 is intended to provide flexibility in structuring LRIP within a program's acquisition strategy to accommodate the unique aspects of individual programs. This invites the opportunity for programs to enter LRIP when production prerequisites have not been met. While additional oversight for LRIP will not substitute for sound program

management, the level of oversight does affect the focus of program management.

Acquisition reform by itself is not enough. There needs to be a cultural revolution in terms of program acquisition requirements. Many of the past reforms have been created to correct the most well recognized acquisition problems, such as developing more accurate cost estimates, enhancing stability, improving the quality of the acquisition workforce, etc. The success of these reforms has been limited because the embedded culture, which proliferates parochial preferences, still exists.

There is a proliferation in the required number of LRIP systems. Current guidance indicates that LRIP quantities should be limited to the minimum required for IOT&E, to establish an initial production base and to permit an orderly increase in the production rate sufficient to lead to full-rate production. There is no formal guideline concerning the acceptable LRIP quantity versus the total planned production quantities. The potential for excessive LRIP quantities occurs because production lines continue as solutions are sought for technical problems.

The use of LRIP can increase program costs. The potential for increased costs occurs when the use of LRIP defers the unit production costs to later years when inflation, labor rates, overhead rates are higher. Additionally, the use of LRIP permits the opportunity for

Follow-on Test and Experimentation to delay the full-rate production decision, resulting in higher unit costs and ultimately higher total program costs. LRIP is not a panacea for program managers. In some cases LRIP may actually increase costs instead of reducing them.

There is no policy for the commitment of long lead funding to support LRIP. The long lead funding decision point represents the commitment of funds to initiate production related decisions. With no policy established, commitment of these funds rests with the program management organization's determination of the contractor's production readiness. There is no requirement to verify completion of predetermined exit criteria. Consequently, commitment of funds cannot be objectively evaluated.

The use of LRIP requires the need to invest in manufacturing tooling and test equipment earlier in the acquisition lifecycle. This can prove to be very costly to both industry and Government should unforeseen political or threat conditions require program redirection.

Concurrency increases the risk that systems will be produced with major flaws. In today's environment, the risk outweighs the benefits of fielding a system early. If concurrency is deemed a necessary part of the acquisition strategy, adequate safeguards must be built into the development process to mitigate the risk.

B. RECOMMENDATIONS

There are several recommendations that can be drawn from the previous conclusions. The following are specific recommendations that the Under Secretary of Defense for Acquisition and Technology should consider through the revision of DoD Instruction 5000.2.

LRIP should be established as a separate acquisition milestone. Because of the number of program changes that can occur between Milestone II and the LRIP decision, a verification of LRIP requirements needs to be established. This will ensure that LRIP is fully supported by program accomplishments and that the LRIP quantities are properly defined based on program needs.

Initial development and operational testing should be completed prior to the LRIP decision. LRIP decisions made prior to the completion of testing can significantly increase the risk of large retrofit costs should a system not meet its operational requirements.

Program specific exit criteria should be established before entry into LRIP. More oversight is essential on the required program accomplishments for initially committing long lead procurement funding for LRIP and entry into LRIP. Accomplishment of production readiness reviews, completion of developmental testing and operational testing prerequisites should be mandatory before making LRIP decisions. A better

relationship between the systems engineering concepts and LRIP decisions are needed.

More oversight regarding the minimum required LRIP quantities should be provided. As the requirement currently exists, the minimum LRIP quantities are based on the articles necessary for test and evaluation, establishment of a production base, and an orderly increase to a full rate production. It is relatively easy to identify items needed for test and evaluation. The ambiguity emerges when identifying quantities to fulfill establishment of a production base and an orderly increase to a full rate production. In order to obtain a more accurate figure, the three determinants of LRIP quantities should be identified separately and not aggregated together. The Milestone II Decision Authority can make the final decision based upon current political, threat or economic conditions.

C. AREAS FOR FURTHER RESEARCH

The following areas should be investigated for potential benefit to DoD:

- **Reengineering of the Acquisition Process** - There are a significant number of issues that could be explored in this rapidly changing environment. Reengineering differs from reforming in that reengineering is the process of identifying and discarding the outdated rules and fundamental assumptions that currently exist. Reforming is simply making incremental changes to "improve" the existing process.

- **Virtual Prototyping and Virtual Manufacturing** - The potential capabilities for increased cost efficiency and

reduced risk for program development have just begun to be realized. With virtual prototypes, design and manufacturing tradeoffs can be evaluated.

- **Defense Science and Technology Strategy** - One of the primary objectives of this acquisition approach is to conduct more rigorous up front technology developments so that the formal acquisition cycle can be made less risky. Areas such as the Advanced Technology Demonstration offer potential for validating the viability and producibility of a technology.

- **Concurrent Engineering** - Preliminary research indicates that this approach could reduce design time and cost by as much as 35 percent and total life cycle costs by as much as 45 percent. There is a significant need for directed, focused research in this area.

- **Test and Evaluation** - The Director, Operational Test and Evaluation, established the Operational Test and Evaluation Capability Improvement Program to acquire test resources for improving the realism of operational tests. Research into the benefits and shortcomings of this program could provide program managers information that may assist in making key acquisition decisions, especially the decision to proceed from development to production.

LIST OF ACRONYMS

10 USC	Title 10, United States Code
AAE	Army Acquisition Executive
AMSAA	Army Materiel Systems Analysis Activity
ACAT	Acquisition Category
ADM	Acquisition Decision Memorandum
AH	Attack Helicopter
AHIP	Advanced Helicopter Improvement Program
ARTI	Advanced Rotorcraft Technology Integration
ASARC	Army System Acquisition Review Council
ATCOM	Aviation and Troop Command
BHTI	Bell Helicopter Textron, Inc
BLRIP	Beyond Low Rate Initial Production
CE	Concept Exploration
CH	Cargo Helicopter
CTT	Combined Test Team
DA	Department of the Army
DAB	Defense Acquisition Board
DAE	Defense Acquisition Executive
Dem/Val	Demonstration/Validation
DLSIE	Defense Logistics Studies Information Exchange
DoD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
DSARC	Defense Systems Acquisition Review Council
DT	Development Testing
DUSA-OR	Deputy Under Secretary of the Army for Operations Research
ECP	Engineering Change Proposal
EEROC	Expedite Essential Required Operational Capability
EMD	Engineering and Manufacturing Development
EOC	Early Operational Capability
EUT&E	Early User Test and Experimentation
FAAO	Field Artillery Aerial Observer
FDT&E	Force Development Test and Experimentation
FLIR	Forward Looking Infrared
FORSCOM	Forces Command
FOT&E	Follow On Test and Evaluation
FY	Fiscal Year
GAO	General Accounting Office
GCMS	Government Composite Mission Scenario

IAS	Integrated Avionics Subsystem
IG	Inspector General
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IPR	In Progress Review
LLTIME	Long Lead Time Items, Material and Effort
LO	Low Observable
LRIP	Low Rate Initial Production
MDAP	Major Defense Acquisition Program
MEP	Mission Equipment Package
MMS	Mast Mounted Sight
OH	Observation Helicopter
OPTEC	Operational Test and Evaluation Command
OT	Operational Testing
PEO	Program Executive Officer
PM	Program Manager
POM	Program Objective Memorandum
PRR	Production Readiness Review
R&D	Research and Development
RAH	Reconnaissance, Attack Helicopter
RDTE	Research Development Test and Evaluation
RFP	Request for Proposal
SAT	Simulation Assessment Team
SDDM	Secretary of Defense Decision Memorandum
SECDEF	Secretary of Defense
SOA	Special Operations Aircraft
SOAR	Special Operations Aviation Regiment
SOF	Special Operations Forces
SSA	Source Selection Authority
SSP	Source Selection Plan
T&E	Test and Evaluation
TEXCOM	Test and Experimentation Command
TOA	Total Obligation Authority
TRADOC	Training and Doctrine Command
TSPR	Total System Performance Responsibility
TTP	Tactics, Techniques and Procedures
USAAVNC	United States Army Aviation Center
USD(A&T)	Under Secretary of Defense for Acquisition & Technology
USSOCOM	United States Special Operations Command

LIST OF REFERENCES

1. General Accounting Office, GAO/NSIAD-93-15, *WEAPONS ACQUISITION; A Rare Opportunity for Lasting Change*, December 1992.

2. Department of Defense Directive 5000.1, *Defense Acquisition*, 23 February 1991.

3. Department of Defense Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, 23 February 1991.

4. Department of Defense Manual 4245.7-M, *Transition from Development to Production*, September 1985.

5. Department of the Navy, NAVSO P-6071, *Best Practices - How to Avoid Surprises in the World's Most Complicated Technical Process*, March 1986.

6. Department of Defense Standard, DOD-STD-1521-B, *Technical Reviews and Audits for Systems, Equipment and Computer Software*, 4 June 1985.

7. United States Code - Title 10.

8. Drezner, Jeffrey A., *The Nature and Role of Prototyping in Weapon System Development*, RAND, 1992.

9. General Accounting Office, GAO/NSIAD-85-68, *Production of Some Major Weapon Systems Began With Only Limited Operational Test and Evaluation Results*, June 1985.

10. General Accounting Office, GAO/NSIAD-90-107, *WEAPONS TESTING; DoD Needs to Plan and Conduct More Timely Operational Tests and Evaluation*, May 1990.

11. Department of Defense Inspector General, *Low Rate Initial Production in Major Defense Acquisition Programs*, 17 June 1993.

12. Defense Systems Management College, *Defense Manufacturing Management*, April 1989.

13. USD(A) White Paper, *Defense Acquisition*, May 20, 1992.

14. General Accounting Office, GAO/NSIAD-90-128, *Test and Evaluation: The Director, Operational Test and Evaluation's Role in Test Resources*, August 1990.

15. Inspector General, Department of Defense, *Low Rate Initial Production in Major Defense Acquisition Programs*, 17 June 1993.

16. Department of Defense Instruction 5000.2, Change 1, *Defense Acquisition Management Policies and Procedures*, 26 February, 1993.

17. Under Secretary of Defense for Acquisition, *Report on Guidelines for Determining the Degree of Risk Appropriate for the Development of Major Defense Acquisition Systems, and Assessing the Degree of Risk Associated with Various Degrees of Concurrency; and Concurrency in Major Acquisition Programs*, 17 April 1990.

18. Blanchard, Benjamin S., Fabrycky, Wolter J., *Systems Engineering and Analysis, Second Edition*, Prentice Hall International Series in Industrial and Systems Engineering, 1990.

19. General Accounting Office, GAO/NSIAD-92-43, *LONGBOW APACHE HELICOPTER; Key Factors Used to Measure Progress in Development Need to Be Changed*, November 1991.

20. General Accounting Office, GAO/NSIAD-90-294, *APACHE HELICOPTER; Serious Logistical Support Problems Must Be Solved to Realize Combat Potential*, September 1990.

21. Interview with LTC James Young, Product Manager - Apache Modernization, and author, 3 September 1993, PEO Aviation, St. Louis, MO.

22. General Accounting Office, GAO/NSIAD-92-43, *LONGBOW APACHE HELICOPTER; Key Factors Used to Measure Progress in Development Need to Be Changed*, November, 1991.

23. Questionnaire completed by LTC Robert Gunning, Product Manager - Longbow Apache, 3 September 1993, St. Louis Mo.

24. Interview with John Shannon, Deputy Project Manager, Kiowa Warrior, and the author, 30 August 1993, PEO Aviation, St. Louis, MO.

25. MEMORANDUM FOR THE UNDER SECRETARY OF DEFENSE FOR ACQUISITION, ATTN: DOT&E, *Subject: Kiowa Warrior Full Materiel Release*, 12 October, 1993.

26. General Accounting Office, GAO/PEMD-88-32BR, *WEAPONS TESTING; Quality of DoD Operational Testing and Reporting*, July 1988.

27. Interview with Jay Rickmeyer, Deputy Product Manager, Special Operations Aircraft, and the author, 2 Sept 1993, PEO Aviation, St. Louis, MO.

28. Product Manager, Special Operations Aircraft, *SOA Acquisition Plan Update Two*, July 7, 1993.

29. Product Manager, Special Operations Aircraft, *Acquisition Strategy*, June 1991.

30. General Accounting Office, GAO/NSIAD-90-267, *SPECIAL OPERATIONS FORCES; Army Plans Highly Concurrent Acquisition Strategy for Costly Helicopters*, September 1990.

31. RAH-66 Comanche Program, *Acquisition Strategy*, June 1992.

32. Questionnaire completed by Robert D. Hubbard, Deputy Program Manager, Comanche, 1 Sept 1993, St. Louis Mo.

33. Robert Hubbard, Deputy Program Manager, RAH-66 Comanche, *Comanche Streamlined Program*, 22 December 1993.

34. Comanche Program, *Test and Evaluation Master Plan (TEMP)*, October, 1992.

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